US Army Corps
of Engineers
St. Paul District

DESIGN MEMORANDUM NO.2
FLOOD CONTROL PROJECT

MINNESOTA RIVER

STAGE 4

CHASKA, MINNESOTA

MARCH 1991

REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*
3/91

2. REPORT TYPE
Final

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE
Minnesota River stage 4 Chaska, Minnesota: design memorandum no. 2, flood control project.

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Corps of Engineers, St. Paul
190 5th St. E.
St. Paul, MN 55101

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution

13. SUPPLEMENTARY NOTES
Includes supplement no. 1, fish and wildlife facilities.

14. ABSTRACT
This design memorandum presents the design and discussion of planning for stage 4 which consists of a levee that protects Chaska from flooding of the Minnesota River. Work includes upgrading existing levee, construction of new levee, a pumping station, outlets with gatewells, interceptor pipe with manholes and inlets, relief wells and sanitary sewer with lift station. Also included is a recreational trail.

15. SUBJECT TERMS
Flood control
Minnesota River

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON / 19b. TELEPHONE NUMBER *(Include area code)*
Unclassified	Unclassified	Unclassified			

DEPARTMENT OF THE ARMY

ST. PAUL DISTRICT, CORPS OF ENGINEERS
1421 U.S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101-9808

REPLY TO
ATTENTION OF

CENCS-ED-M (1110)

24 APR 1991

MEMORANDUM FOR Commander, North Central Division, ATTN: CENCD-PE-ED, 536 South Clark Street, Chicago, Illinois 60605-1592

SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota, Design Memorandum No. 2, Stage 4, Minnesota River

1. Subject report is submitted in accordance with EC 1110-2-265 for your review and approval.

2. This design memorandum presents the design improvements for construction of the levee modifications, pump station, and related structures as well as recreational features for the Minnesota River at Chaska, Minnesota.

FOR THE COMMANDER:

Encl (16 cys)
Chaska Stage 4 DM

Roger L. Baldwin

ROGER L. BALDWIN
Colonel, Corps of Engineers
Commanding

FLOOD CONTROL
MINNESOTA RIVER AT
CHASKA, MINNESOTA

DESIGN MEMORANDUM NO. 2

MINNESOTA RIVER

DESIGN MEMORANDUM SCHEDULE

Number	Scheduled Completion	Submitted NCD	Submitted OCE	Approved
General	Mar 84	6 Mar 84	May 84	Jul 84
1. Chaska Creek (Stage 2)	Jul 84	Dec 84	Feb 85	Aug 85
2. Minnesota River (Stage 4)	Mar 91(1)			
3. East Creek (Stage 3)	Feb 92			

(1) The Fish and Wildlife Mitigation Features are not included. These will be provided separately.

EXECUTIVE SUMMARY

The Chaska, Minnesota Flood Control project was authorized for construction by Section 102 of the 1976 Water Resources Development Act, Public Law 94-587. Chaska is on the Minnesota River in Carver County in south-central Minnesota about 20 miles southwest of Minneapolis-St. Paul.

The flood control project provides flood protection to Chaska by diverting both Chaska and East Creeks and by providing a levee that protects against flooding by the Minnesota River. The creek diversions provide Standard Project Flood protection and the levee provides one-percent chance flood protection. Pertinent data is on the following page.

The total estimated project cost is $38,700,000. Federal costs are estimated at $29,000,000; non-Federal costs are estimated at $9,700,000. The estimated cost for Stage 4, Minnesota River is $10,955,000. Federal cost for Stage 4 are estimated at $8,243,000; non-Federal costs are estimated at $2,712,000.

The Local Cooperation Agreement was executed in September 1988. The Stage 1 construction contract was awarded in September 1988. The Stage 2 construction contract was awarded in August 1989. Stages 3 and 4 are scheduled for a construction contract award in October 1993 and January 1993 respectively.

This Design Memorandum presents the recommended design for Stage 4, Minnesota River levees. The design includes 4,200 feet of improved levee, 2,800 feet of new levee, one 18,000 gpm pump station, two outlets with gatewells, interceptor pipe with manholes and inlets, relief wells, and sanitary sewer with lift station. Also included is a recreation trail.

PERTINTENT DATA

Project Document - House Document 94-644, 94th Congress, 2nd Session.

Project Authorization - 1976 Water Resources Development Act (Public Law 94-587).

Project Purpose - Flood Control.

Location - The project is located on the Minnesota River in Carver County and Chaska, Minnesota, and includes both Chaska and East Creeks, which are tributaries of the Minnesota River.

Hydrology and Hydraulics

Watershed Drainage Area	
Chaska Creek Diversion Inlet	14.9 Square Miles
East Creek Diversion Inlet	10.1 Square Miles
Minnesota River	16,600 Square Miles
Design Flood Event	
Chaska Creek	Standard Project Flood
East Creek	Standard Project Flood
Minnesota River	One-percent Chance Flood
Design Flows	
Chaska Creek Diversion	6,040 cfs
East Creek Diversion	5,500 cfs
Minnesota River	168,000 cfs

Principal Items of Work

Diversion Channel	
Stage 2	5,800 LF
Stage 3	6,000 LF
Levee Improvement	
Stage 2	2,100 LF
Stage 4	4,200 LF
New Levee, Stage 4	2,800 LF
Drop Structures, Stage 3	2
Pumping Station, Stage 4	1
Bridges	
Stage 2	4
Stage 3	4

Economics

Federal first cost	$29,000,000
Non-Federal first cost	9,700,000
Total first cost	38,700,000
Average annual operation & maintenance cost	42,000
Total average annual cost	3,149,900
Average annual benefits	2,260,000
Benefit-cost ratio	0.72

FLOOD CONTROL
MINNESOTA RIVER AT CHASKA, MINNESOTA

DESIGN MEMORANDUM NO. 2, STAGE 4

FISH AND WILDLIFE FACILITIES

SUPPLEMENT NO. 1

Department of the Army
St. Paul District, Corps of Engineers

May 1993

FLOOD CONTROL
MINNESOTA RIVER AT CHASKA, MINNESOTA

DESIGN MEMORANDUM NO. 2, STAGE 4

FISH AND WILDLIFE FACILITIES

SUPPLEMENT NO. 1

TABLE OF CONTENTS

Item	Page	Paragraph
Introduction	1	1,2
References	1	3-5
Moist Soil Unit		
General	2	6-8
Hydraulics	2	9-13
Geotechnical	4	14-18
Structural	5	19-26
Mechanical	6	27-30
Cultural	7	31
Chaska Lake Water Control Structure		
General	7	32-36
Hydraulics	8	37,38
Structural	9	39,40
Cost Estimate	9	41
Operation and Maintenance	10	42
Real Estate	10	43
Coordination	10	44
Schedule for Design and Construction	10	45

FIGURES

Number	
1	Soil Classification Record Sheet
2	Soil Classification Record Sheet
3	Power Unit Specifications
4	Power Unit Information
5	Trash Pump Specifications

ATTACHMENTS

Number	
1	M-CACES Estimate
2	Letter from Fish and Wildlife Service

PLATES

Number	
S-1	Elevation - Discharge - Head Curves
S-2	Elevation - Area - Storage Curves
S-3	Elevation - Time Curves
S-4	Elevation - Discharge Curves (Chaska Lake Outlet)

DRAWINGS

Sheet Number	
1	Location, Map, General Plan and Drawing Index
2	Boring Logs, General Notes, Boring Legend, Logs 83-53M, 89-127M thru 89-129M
3	Logs 91-149M thru 91-152M
4	Logs 91-153M thru 91-157M
5	Control Structure General Plan
6	Dike, Island, and Ditch Cross Sections
7	Control Structures Profiles
8	Control Structures and Platforms
9	Inlet Portable Pump, Crane & Wall Plan, Elevation, Section and Diagram

FLOOD CONTROL
MINNESOTA RIVER AT CHASKA, MINNESOTA

DESIGN MEMORANDUM NO. 2, STAGE 4

FISH AND WILDLIFE FACILITIES

SUPPLEMENT NO. 1

INTRODUCTION

1. This supplement explains the design and gives details of the Fish and Wildlife facilities that are to be constructed as a mitigation feature for the Chaska Flood Control project. These facilities will be operated by the U.S. Fish and Wildlife Service (FWS).

2. Construction of the flood control features for the Minnesota River at Chaska, Minnesota Flood Control project will result in the loss of 40 acres of terrestrial habitat, excluding cropland and urban grasslands. A detailed evaluation of the impacts and the mitigation plans considered is presented in the references cited. The authorized mitigation plan for the project consists of two primary features: (1) construction of a 19 acre moist soil unit on the Chaska Lake Unit of the Minnesota Valley National Wildlife Refuge, and; (2) the construction of a water control structure on Chaska Lake. This supplement presents the design of these mitigation features.

REFERENCES

3. Limited Reevaluation Report and Final Supplement to the Final Environmental Impact Statement for Flood Control and Related Purposes, Minnesota River at Chaska, Minnesota, August 1982.

4. General Design Memorandum and Draft Supplement II to the Final Environmental Impact Statement, Minnesota River at Chaska, Minnesota, Flood Control Project, Revised August 1984.

5. Final Supplement II to the Final Environmental Impact Statement, Minnesota River at Chaska, Minnesota, Flood Control Project, February 1985.

MOIST SOIL UNIT

GENERAL

6. The completed moist soil unit will be a shallow, man-made wetland which will be managed to provide feeding habitat for songbirds, wading birds and waterfowl. This feature will be created by diking a site that is currently in cropland. The system will consist of two cells that can be flooded to a depth of about two feet and managed independently. The General Plan for the moist soil unit is shown on Sheet 5.

7. The general design of the moist soil unit consists of three-foot high dikes with a 12 foot top width. The top of the dikes will have a gravel surface that can be driven on with maintenance and operational equipment. Selected areas of the dikes will be covered with rock to ensure dike integrity during flood events on the Minnesota River. Three stoplog control structures, one at the outlet for each unit and one between the two management cells, will allow for independent water management of the management cells.

8. Water supply for this feature is Chaska Lake. A concrete pad will be installed on the west side of the unit adjacent to Chaska Lake. The FWS would use a portable pump to pump water from Chaska Lake to flood the cells.

HYDRAULICS

9. Three 24" corrugated metal pipe (cmp) culverts are required to drain the moist soil units. Two culverts, about 90'-3" and 95'- 3" long with control structures, will be located on the northeast side of the unit to drain each cell toward the Minnesota River and permit backflow from the river into the cells during the rise and fall of the river. A 37'-5" culvert will also be provided near the north end of the interior dike to permit the regulation of flow from one cell to the other. Elevation-discharge-head curves for the proposed culverts are presented on Plate S-1. A trapezoidal earth ditch, about 185' long, with a base width of 15 feet and 1 on 3 side slopes, is required downstream from the 90'-3" and 95'-3" culverts. The ditch will have a bottom elevation of about 703.10 at the upstream end and slope downstream on a grade of about 1.6 percent. A stoplog control structure is to be constructed at the inlet to each culvert to permit the regulation of pond levels.

10. Riprap is recommended at each end of the three culverts to prevent possible erosion and/or scouring. The required riprap blanket at each end of the 90'-3" and 95'-3" culverts will be 12" thick, extend about 10' upstream and downstream from each culvert opening, and extend to a height equal to the top of the ditch or crown of the culverts. The required riprap blanket at each end of the 37'-5" culvert is to be 12" thick and cover a rectangular area

beginning about 10' from the end of the culvert, extend 5' to each side of the culvert centerline, and extend up the berm adjacent to the culvert to a height equal to the top of the annular fill surrounding the culvert. The required riprap gradation is as follows:

Percent Lighter By Weight	Limits of 165 Pound Stone Weight In Pounds Maximum	Minimum
100	86	35
50	26	17
15	13	5

11. The proposed plan is to fill the moist soil units to elevation 705.5 during the spring and fall months, and empty the units each summer. When the units are to be emptied and bulkheads are removed, outflow through the culverts with an initial interior pond level of 705.5 will be about 11 cfs through one pipe or about 22 cfs, if both pipes are opened, resulting in an exit velocity of about 3.5 feet per second at the outlet end of each pipe. With a discharge rate of about 11 cfs, the estimated depth and average velocity in the ditch will become about 0.5 feet and 1.5 feet per second, respectively. With a discharge rate of about 22 cfs, the estimated depth and average velocity in the ditch will become about 0.7 feet and 2.1 feet per second, respectively. The base width for the proposed ditch is required to provide proper maintenance and permit the deposition of sediment without obstructing the outflow from the upstream culverts. Elevation-area-storage relationships for each of the moist soil units are presented on Plate S-2. As indicated on Plate S-3, the required time to empty one of the units using only one of the outlet pipes (or both units using both outlets simultaneously) from a starting elevation 705.5 will be about 45 hours. It would take about 90 hours to empty both units using only one outlet.

12. The design of the gravity outlets and the riprap are based on the criteria presented in Appendix A of Design Memorandum No. 2, paragraph A-49 (page A-12), references h, i, and j; assuming a Manning's roughness coefficient of 0.024 for corrugated metal pipe, an entrance coefficient of 0.5 and a stone weight of 165 pounds. The design of the earth ditch is based on criteria presented in EM 1110-2-1601 (subparagraph A-49c, above reference), assuming a Manning's coefficient of 0.08 for depths less than 0.5 feet, 0.06 for depths from 0.05 to 1.5 feet, and 0.04 for depths greater than 1.5 feet.

13. Although it can be shown that no riprap protection is required on the dikes, the FWS requests that about 1,200 linear feet of dike on the north side of the units be protected with rock protection. Their experience is that the downstream portion of the moist soil unit will erode during receding river levels.

GEOTECHNICAL

14. The site is located on the flat floodplain just south of Chaska's business district. Ground surface elevations range from approximately 702 to 708 (1929 Adjusted). The site is bounded on the west by Chaska Lake, on the north by Chaska Creek, and on the east and south by the Minnesota River. The soil stratigraphy and top of bedrock was defined by borings while the bedrock stratigraphy and aquifer characteristics were inferred from published U.S. Geological Survey data and local water records. The subsurface consists of alluvial clays, silts and sands to elevation 530, (soil thickness approximately 175 feet). The underlying bedrock, from top to bottom consists of; dolomitic siltstone of the St. Lawrence Formation, interbedded sandstone and shale of the Franconia Formation, interbedded sandstone and shale of Dresbach Formation, and the Hinkley Sandstone. The alluvial sand is a local aquifer capable of moderate to high yields. The Franconia and upper beds of the Dresbach Formation comprise a regional aquifer capable of moderate yields, while the Hinkley Sandstone and the lower beds of the Dresbach Formation comprise a regional aquifer capable of high yields.

15. A boring was taken near the site in 1983 in the early planning for the Chaska Creek portion of the Chaska Flood Control project. Three borings were taken in 1989 to determine if the upper soil layer was suitable for constructing a moist soil unit. One deep boring was taken in 1991 to determine if an adequate supply of water could be obtained by installing a well in the underlying sand aquifer. Additional shallow borings were taken in 1991 to determine the continuity and thickness of the upper layer of impervious soil. The boring locations are shown on Sheet 5 and the boring logs are shown on Sheet 2 through Sheet 4. Atterberg limits and gradation tests performed on samples from the 1983 and 1989 borings are shown on figures 1 and 2.

16. The site has a surface layer of clay that appears to be at least four feet thick. Underlying this is a fairly thick layer of interbedded clays, silts, and sands which extends to approximately elevation 620. Below this is a fairly thick layer of sands and silty sands which extends to the bedrock at elevation 530. This layer of sands contains some clay seams.

17. The dikes will have either 1V to 3H side slopes if covered with riprap or surge rock protection or 1V to 4H side slopes if grass covered. The dikes will have a 12 foot top width and gravel surface. Surge rock, located and sized as directed by the FWS, will be placed on selected portions of the dikes. The gradation and thickness of the surge rock is shown in Table A. Areas of the unit that do not have gravel surface, surge rock or riprap will receive 4 inches of topsoil and be seeded. Outlet control structures placed in the dikes will be backfilled with impervious material.

TABLE A

Surge Rock

type	thickness	percent passing	sieve size
B	8 or 12	100	8"
		0	4"
A	4 or 6	100	3"
		0	#200

18. The FWS requested that the water supply be capable of filling the cells in 20 days. The flow rate required was calculated based on an early plan of the Moist Soil Unit and assuming an average water depth of 1.75 feet. Evaporation losses were based on information contained in the "Hydrology Guide for Minnesota" published in 1955 by the Soil Conservation Service. Seepage losses were calculated assuming the clay layer at the bottom of the cells has a thickness of two to three feet with some of that layer disturbed by plowing. The calculated flow rate was increased 25 percent for a safety factor to obtain a flow rate of 600 gallons per minute.

STRUCTURAL

19. Structural features consist of three water control structures. A water control structure consists of a half riser stoplog closure at the inlet and a pipe with a flared end section at the outlet. The stoplog closure will control the water surface at each cell.

20. The cmp used for the half riser and outlet pipe shall be circular, galvanized and bituminous coated with 2-2/3 inches x 1/2 inch corrugations. The half rise is made from 48 inch diameter 12 gauge cmp. Half the pipe is used for the stoplog closure above grade. The full diameter of pipe below grade is filled with concrete for the base. The concrete also acts as weight to resist flotation of the riser. The outlet pipe shall be 24 inch diameter 16 gauge cmp. Connecting bands at pipe joints shall be watertight and flexible. The flared end section and connection bands shall be fabricated from the same material as the outlet pipe.

21. The steel angles used in the half riser for stoplog grooves and bracing shall have welded connections. The entire riser section shall be galvanized after fabrication.

22. Stoplogs shall be made of any available No. 1 structural grade rough sawn lumber. The stoplogs shall be cut to the dimensions shown on the drawings and treated with preservative. The size of each stoplog will be dependent on availability and top of stoplog

elevation required, but must have a minimum net width of 3-1/2 inches. Lift rods for the stoplogs shall be 1/2 inch diameter and 7 inches long. A locking bar to prevent stoplog removal by unauthorized persons shall be provided on each stoplog closure.

23. Each control structure will have a platform to provide access to the stoplog closure from the dike. The platforms will be supported on the outlet pipe and half riser stoplog closure. The post spacing can be adjusted to provide a better approach from the dike or to accommodate pipe lengths. The spacing shall not exceed 8 feet.

24. The angles used for the platform shall be ASTM A36 steel. The transverse frames shall have welded connections to provide lateral support. Truss bars will provide lateral support in longitudinal direction. The platform members, frames and bolts shall be galvanized after fabrication.

25. The structural features associated with the water supply from Chaska Lake are a concrete pad in the ditch for the portable pump and a concrete wall supporting the crane which will lift the pump onto the pad. The concrete shall have a minimum 28-day compressive strength of 4,000 psi and reinforcement shall be ASTM Grade 60.

26. The crane to be provided will be a 500 pound capacity jib crane specifically designed for lifting pumps. All anchors and fasteners will be stainless steel. The crane will be designed to sit outdoors for extended periods of time. A stainless steel cable will provide 30 feet of lift and loads shall be raised and lowered with a hand winch. The boom shall rotate 360 degrees and fold down for storage.

MECHANICAL

27. The moist soil unit will be filled using water pumped from Chaska Lake. The hydraulic pump system will include a diesel power unit, submersible pump and discharge tubing. The diesel power unit will be mounted on a trailer and parked on top of the dike as shown on Sheet 9.

28. Operation. Setup shall require one person about four hours. Spring and fall the diesel power unit will be towed to the moist soil unit and parked on the dike. The size and weight of the diesel power unit allows towing with a 1/2 ton pickup truck. The pump and tubing can be transferred in the pickup box. The diesel power unit shall be leveled using the trailer's adjustable legs. The trailer tongue can be removed for security. The pump weight is 67 pounds. Discharge tubing shall be connected to the pump and placed over the dike to the moist soil unit. Hydraulic hoses need to be connected from the diesel power unit to the pump. The hydraulic fluid reservoir, motor oil, radiator and diesel fuel tank

will need to be checked and filled before starting the motor. Operating costs are: $1.00 per gallon diesel fuel * 26 gallons per day * 20 days * 2 seasons = $1,440.00 per year.

29. Maintenance. Each day of operation the diesel power unit fluid levels should be checked and filled.

30. Equipment. The diesel power unit (figures 3 and 4) will include a 22 horsepower, water cooled diesel engine; hydraulic pump, hydraulic reservoir, 50 feet of pressure and return hydraulic hoses with quick disconnect couplings; control panel with automatic safety shutdown for low hydraulic oil level, high hydraulic oil temperature, low engine oil pressure and high engine temperature, tachometer, ammeter, throttle control; high speed single axle trailer with adjustable stabilizing legs and removable tongue; 12V battery; and 160 gallon self contained fuel tank. To deter vandalism, the entire unit will be covered with wire mesh and a duckbill anchoring system will be installed. Pump selection will be a submersible open type trash pump (figures 5 and 6) designed to pump water containing solids such as mud, weeds and sticks. The pump capacity will be 710 gallons per minute maximum flow rate with 20 feet of head, assuming 10 feet of friction losses. Friction losses include 60 feet of 4 inch discharge tubing, pump column discharge losses, and fitting losses. The bearing housing shall be high grade cast steel. The bearings and seals will be lubricated by low pressure hydraulic oil eliminating the need to grease the bearings each day. The pump has the ability to run dry without damage. The discharge tubing shall be Butyl Nylon, 4 inch diameter and 60 feet long.

CULTURAL

31. In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, the National Register of Historic Places has been consulted. According to the <u>Federal Register</u>, as of May 22, 1991, there are no sites listed on or eligible for the National Register that will be affected by construction of the proposed moist soil unit. The moist soil unit was surveyed for cultural resources in April 1991. No cultural resources were encountered. The results of this survey are being coordinated with the Minnesota State Historic Preservation Office.

CHASKA LAKE
WATER CONTROL STRUCTURE

GENERAL

32. The water control structure on Chaska Lake will enable the FWS to manipulate water levels on Chaska Lake. This will allow for various desired management objectives such as to enhance the growth

of submerged aquatic vegetation or to provide the optimum ratio of emergent vegetation to open water.

33. The control structure is designed so that Chaska Lake can be completely drained by gravity during normal and low flows on the Minnesota River. The STAGE-DURATION CURVE plate A-10 in Appendix A of Design Memorandum No. 2, can be used to determine gravity drainage limitations.

34. Dredging in Chaska Lake would be required to ensure that the proposed outlet for Chaska Lake Ditch and the Moist Soil Unit Inlet Ditch would operate effectively. The dredged channel for the Chaska Lake Ditch would be about 800 feet long with an average dredge cut of about 1 foot. The dredge cut for the Inlet Ditch would be similar in depth and would run for about 100 feet. A total of about 300 cubic yards of material would be dredged.

35. The sediments in Chaska Lake are primarily silt and silt clay. Land use around Chaska Lake has historically been undisturbed woodlands on the north and west sides of the lake, and moderate agricultural use on the south and east sides of the lake, with these areas being used intermittently for hayland and row crops.

36. It is anticipated that dredging would be done using a portable hydraulic dredge. The constructed moist soil unit would be utilized as the containment area for this operation. Dredged material would be used as topsoil for the moist soil unit to provide a seed bank for wetland plan species.

HYDRAULICS

37. The proposed outlet from Chaska Lake to Chaska Creek will consist of a 780' trapezoidal earth ditch, a 63'-1", 24" cmp culvert with control structure and scourhole, and a 95' trapezoidal earth ditch. The control structure is to consist of a 48" half cmp riser at the upstream end of the culvert with stoplog slots, and is required to permit the lake to be drained. A riprapped scourhole, 4' wide, 6' long and one foot deep with 1 on 3 side slopes, is required at the downstream end of the culvert to dissipate the outflow energy from the culvert. The trapezoidal ditches will be constructed with a 4' base width, 1 on 3 side slopes, and a 0.3 percent slope. Based on a 0.3 percent slope, the recommended invert elevations for the proposed culvert are 697.71 at the upstream end and 697.49 at the downstream end. The channel bottom for the upstream ditch will drop from about elevation 700.0 at the lake outlet to about 697.2 at the entrance to the culvert. (It is recommended that the last 10' of ditch adjacent to the culvert be constructed with a bottom elevation of about 697.7 at the upstream end and 697.2 at the entrance to the culvert to prevent the transportation of sediment and riprap into the culvert.) The channel bottom for the downstream ditch will drop from about 697.5

at the downstream end of the scourhole to about 697.2 at Chaska Creek. Riprap, 12" thick, is required about 10' upstream of the culvert and 24' downstream of the culvert and should extend up the sides of the ditch, scourhole, and culvert fill to the top of the ditch or an elevation equal to the crown of the culvert, whichever is less.

38. The proposed plan is to keep the stoplogs in place, except when the lake is to be drained. Based on a design lake level of about 704.3, the design outflow through the culvert will be about 27.5 cfs, which will result in an exit velocity from the culvert of about 8.8 feet per second. To prevent the possibility of scour or erosion at the entrance and exit from the culvert, riprap of the same gradation and thickness as presented in paragraph 10 above is recommended. Elevation-discharge rating curves for the Chaska Lake outlet structures are presented on Plate S-4. Based on a discharge of about 27.5 cfs, the estimated maximum water surface elevations at the entrance to the upstream ditch, upstream end of the culvert, and downstream end of the culvert will be about 704.3, 704.3 and 699.2, respectively. An elevation-storage curve for Chaska Lake is presented on Plate S-2. As indicated on Plate S-3, the estimated time required to drain the lake will be about 9 days. Criteria used to design the culvert, ditches and riprap cover are the same as presented in paragraph 12.

STRUCTURAL

39. The structural feature of the Chaska Lake Water Control Structure is one water control structure. The new control structure will replace an existing 18 inch cmp. The water control structure consists of a half riser stoplog closure at the inlet and a pipe with a flared end section at the outlet. The stoplog closure will control the water surface in the Chaska Lake ditch.

40. The description of the Chaska Lake Water Control Structure will be the same as described for the Moist Soil Unit Water Control Structures. The only difference is there will be handrails provided on the platform due to the height of the platform above the ground.

COST ESTIMATE

41. The M-CACES cost estimate was completed by work analysis. It is included as Attachment 1. The estimated construction cost with contingency is $350,000.00.

OPERATION AND MAINTENANCE

42. The FWS will operate and maintain the moist soil unit and water control facilities.

REAL ESTATE

43. The mitigation facilities proposed will be constructed on FWS refuge land.

COORDINATION

44. The design of the moist soil unit and water control facilities have been coordinated with the FWS and City of Chaska. See attached letter from the FWS.

SCHEDULE FOR DESIGN AND CONSTRUCTION

45. Plans and Specifications are to be completed in September 1993 so that a construction contract can be awarded in December 1993. Construction would be completed by 1 August 1994.

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska Flood Control	Boring No: 83-52M through 83-57M	MRD Lab. No: 84/34
Station: Range: Surf. Elev:	Depth To Water Table:	Bottom Of Hole:

Sample No	Depth To Bottom Of Sample	Moisture (%)	L.L.	P.I.	Hyd. Analysis Fines 005	Hyd. Analysis Fines 02mm	200	60	40	20	10	4	3/8	3/4	1 1/2	3 in	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech. MEMO 3-357, May 67	Remarks PL
Hole 83-52M																							
3	8.6						7	9	15	48	88	100					0.98	0.58	0.19	5.2	1.8		
7	16.5						5	30	92	100							0.28	0.18	0.088	3.2	1.3		
12	36.5	23.4	35	15																			20
13	41.5	21.7	NP	NP			47	96	100														
Hole 83-53M																							
2	3.5	35.4	45	24																			21
4	9.5	32.3	39	22																			17
6	14.5	32.5	35	13																			22
11	29.5	91.6	210	171																			Organic 39
Hole 83-54M																							
1	1.5	7.5	31	13																			18
3	11.5						18	69	99	100													
5	15.5						7	21	71	99	98	100					0.35	0.22	0.090	3.9	1.5		
Hole 83-55M																							
1	2.0						38	52	68	77	84	90	93	97	100								
2	4.5						43	84	90	93	95	97	100										
5	14.5						18	25	44	60	70	78	86	92	100								
7	22.8						4	9	33	52	62	73	83	88	100		1.5	0.42	0.18	8.3	0.65		
Hole 83-56M																							
2	7.5	29.0	34	16																			18
3	12.5						3	6	13	21	31	49	77	88	100		6.4	1.8	0.30	2.13	1.8		
4	14.5						5	14	58	82	95	100					0.43	0.24	0.14	3.1	0.96		
Hole 83-57M																							
4	14.5						5	7	14	21	30	42	54	64	100		14.0	1.9	0.27	51.9	0.96		
5	19.0						6	9	20	30	43	60	73	83	100		5.0	0.90	0.19	25.3	0.85		

MRD FORM 16 NOV. 75 EDITION OF MAY 70 IS OBSOLETE

Table - 1

OTHER TESTS ON BORING 83-53M

depth	L.L.	P.I.	P.L.	Wc	Classification	Type of test
17'-19'	81	44	37	83%	MH	Q & Consolidation
26'-28'	207	133	74	74%	OH	Q & Consolidation
42'-44'	26	10	16	30%	CL	Q
50'-51'	31	16	15	24%	CL	Q

Figure 1

SOIL CLASSIFICATION RE . SHEET

PROJECT: Chaska Flood Control Project - East Creek	BORING: 89-127m, 89-128m and 89-129m	WRD LAB NO. 90/137
STATION: / RANGE: / SURF.ELEV.:	DEPTH TO WATER TABLE:	BOTTOM OF HOLE:

SAMP NO.	DEPTH TO BOTTOM OF SAMP.	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE 200	SANDS 80	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	89-127																							
1	4.5	18.9	37	20																				17
2	9.5						41	96	100															
4	14.0						25	91	100															
Hole	89-128																							
1	3.2	22.8	67	39																				28
2	5.0	30.5	37	22																				15
3	5.5						26	91	100															
5	14.5						45	96	100															
Hole	89-129																							
1	0.5	13.6	50	29																				21
2	4.5	8.6	26	12																				14

TABLE 3

Figure 2

DEWATERING DESIGNERS PUMPS

POWER UNITS

HYDRAULIC POWER UNITS

Back in the 17th century Blaise Pascal discovered that a fluid under pressure could be used to transmit power.

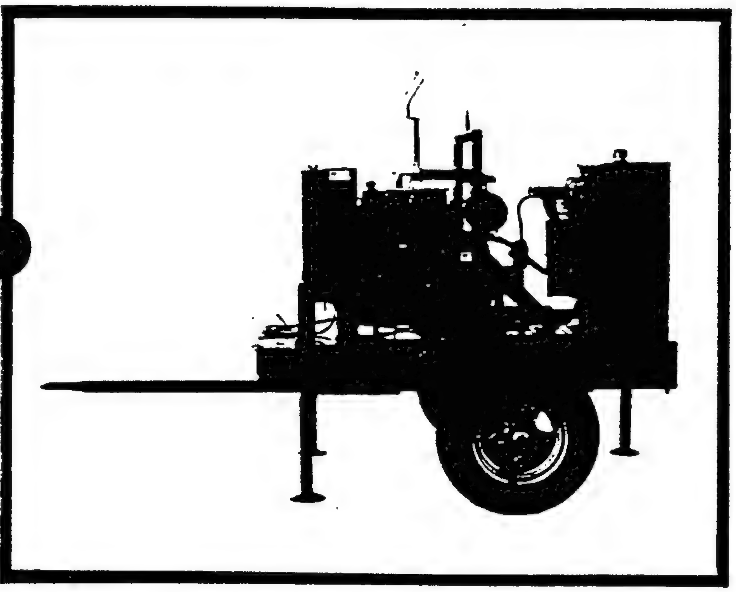
Hydraulics is transmitting power through a fluid, in a fluid conductor to do work. This is the most unique method of transmitting energy to do work. It is less cumbersome than straight shaft mechanical transmission. It has virtually infinite speed control and is more precise in controlling energy.

By use of the hydraulic motors compactness, light weight, and the flexibility of the hydraulic hoses, permits the power source to be remotely located in a safe and accessible area. It also provides a means of varying the speed of the impeller by controlling the flow of the oil to the pump head.

D & D uses this versatile, horsepower dense, form of power transmission, to drive their pumps. By utilization of variable displacement or multi-section pumps allows D & D power units to drive a wide range of pump heads or multiple pump heads.

With the availability of additional options the power units can drive generators, air compressors and hydraulic tools, making D & D power units a stand alone power source.

Power units are available in Diesel or Electric on trailer or skid mounts and may be custom built to your needs.



HYDRAULIC POWER UNIT SPECIFICATIONS DIESEL

Power Unit Model	Recommended Pump Heads	H.P.	Hose Size	Volume Cu. Ft./Cu. Mtr.	Weight Lbs./Kg.
50/60*	3LT, 4LT	16	.50" & .50"	19.5/.54	250/114
75	4LT, 8AX	19	.50" & .50"	21/.58	700/318
* 100	4T, 10AX	22	.50" & [illegible]	58/1.6	1300/590
250	4S, 6T, 12AX, 14AX	40	.75" & 1.0"	165/4.7	1625/737
400	6S, 8T, 16AX	65	1.0" & 1.25"	235/6.7	2750/12147
500T*	6S, 8T, 20AX	100	1.0" & 1.25"	235/6.7	2900/1318
600	10T, 20AX	89	1.25" & 1.50"	286/8.1	3650/1656
700T*	12T, 24AX	119	1.25" & 1.50"	286/8.1	3800/1727
800	18T, 24AX, 30AX	146	1.50" & 2.0"	400/11.3	4650/2109
1000	36AX, 48AX	A.R.	A.R.	C.F.	C.F.

*Special Head Requirements
A.R. — As Required
C.F. — Consult Factory

HYDRAULIC POWER UNIT SPECIFICATIONS ELECTRIC

Power Unit Model	Recommended Pump Heads	H.P.	Hose Size	Volume Cu. Ft./Cu. Mtr.	Weight Lbs./Kg.
50	3LT	15	.50" & .50"	32/.91	635/289
75	4LT, 8AX	20	.50" & .50"	32/.91	555/298
100	4T, 10AX	25	.50" & .75"	49/1.4	725/329
250	4S, 6T, 12AX, 14AX	30	.75" & [illegible]	49/1.4	310/368
400	6S, 8T, 16AX	50	1.0" & 1.25"	[illegible]	1635/743
500*	6S, 8T, 16AX	50	1.0" & 1.25"	[illegible]	1701/773
600	10T, 20AX	75	1.25" & 1.50"	[illegible]	1750/795
700*	12T, 24AX	100	1.25" & 1.50"	[illegible]	2095/952
800	18T, 24AX, 30AX	125	1.50" & 2.0"	[illegible]	4650/2114
1000	36AX, 48AX	A.R.	A.R.	C.F.	C.F.

*Special Head Requirements
A.R. — As Required
C.F. — Consult Factory

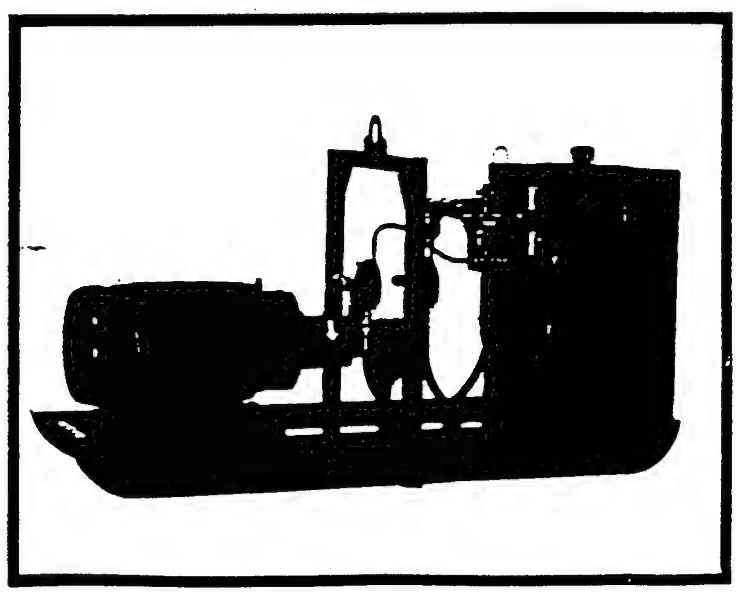


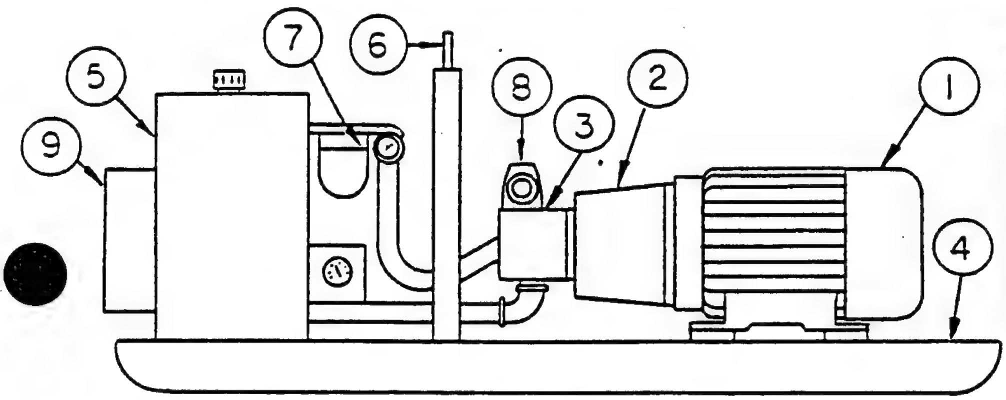
FIGURE 2

STANDARD FEATURES

- High speed trailer or "I" beam construction skid
  Easy to move or set in place.
- Three stabilizing legs on trailer
  Keeps power unit level on any terrain.
- Prime mover can be diesel engine or electric motor. Utilizes most economical power source.
- Centralized control and gauge panel
  Easy start up and monitoring of system.
- Automatic safety shutdowns
  Protection for low hydraulic oil, high hydraulic oil temp., low engine oil pressure and high engine temperature.
- Prime mover and hydraulic pump close couples
  No hydraulic pump failures due to belt drives.
- Hydraulic oil suction strainer, return filter, tank filter breather. Protects hydraulic system against dirt contamination.
- Large fuel tank
  24 hours of run time or more.
- Control valve unloads hydraulic system
  Start and shutdown are done with no load.
- 50′ of pressure and 50′ return hydraulic hose
  Power unit can be remotely located for safety.
- Spin-on hydraulic hose connection
  Fast and easy setup.

OPTIONS

- Tandem or Variable Displacement Pump
- Extra Hydraulic Hose (up to 150′)
- Flow Control to Operate Tools
- Generator or Air Compressor Drive.

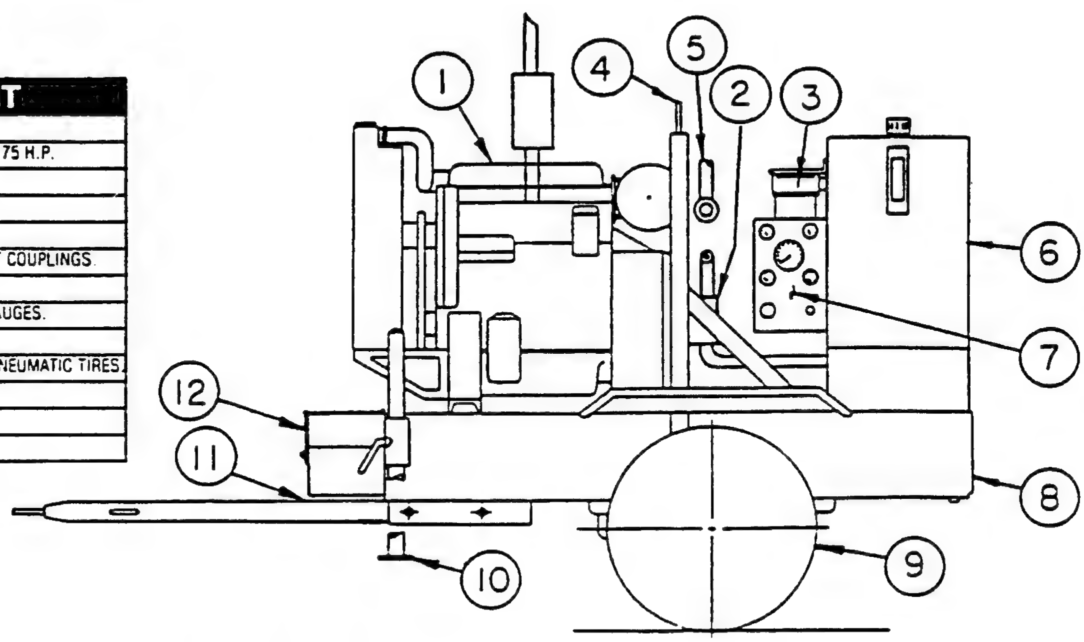


ELECTRIC POWER UNIT

ITEM	DESCRIPTION
1	MOTOR-ELECTRIC. 15 TO 150 H.P.
2	HYDRAULIC PUMP TO MOTOR ADAPTER
3	PUMP-HYDRAULIC. 4 TO 86 G.P.M.
4	SKID.
5	HYDRAULIC RESERVOIR.
6	ROLL BAR & LIFTING BRACKET.
7	FILTER-RETURN LINE. SPIN ON.
8	HYDRAULIC HOSE W/QUICK DISCONNECT COUPLINGS.
9	ELECTRIC MOTOR CONTROL PANEL.

DIESEL POWER UNIT

ITEM	DESCRIPTION
1	ENGINE-DIESEL. WATER COOLED. 22 TO 175 H.P.
2	PUMP-HYDRAULIC. 8 TO 86 G.P.M.
3	FILTER-RETURN LINE. SPIN-ON.
4	ROLL BAR & LIFTING BRACKET.
5	HYDRAULIC HOSE W/QUICK DISCONNECT COUPLINGS.
6	HYDRAULIC RESERVOIR.
7	ENGINE ELECTRIC CONTROL PANEL W/GAUGES.
8	FUEL TANK-SELF-CONTAINED.
9	AXLE ASS'Y-HIGH SPEED 1, 2 OR 3 AXLE, PNEUMATIC TIRES.
10	ADJUSTABLE LEGS.
11	REMOVEABLE TONGUE.
12	BATTERY-12 VOLT.



Corp. & Mfg. Facilities
D&D Machine & Hydraulics, Inc.
10945 Metro Parkway S.E.
Fort Myers, FL 33912
813-275-7177 — 813-275-5350 FAX
Cable DD Pumps — Telex 759033

DEWATERING DESIGNERS PUMPS

N.E. Regional Sales Office
Commercial Ave.
Hudson, N.H. 03051
603-886-0522
FAX 603-889-6379

FIGURE 4

DEWATERING DESIGNERS PUMPS

TRASH PUMP

SUBMERSIBLE OPEN TYPE TRASH PUMP

Submersible Trash Pumps are designed to pump water containing solids such as mud, weeds, trash, sticks and other foreign materials which can not be pumped with conventional centrifugal pumps.

The semi-open intake design permits the inflow of water at varying rates and does not require any suction lines. As the inflow of water increases or decreases, the pump motor can be regulated to handle the varying conditions at maximum efficiency and minimum wear on the pump head.

Whatever the dewatering requirement may be; from gradual seepage of water into a manhole; the dewatering of a borrow pit or quarry that requires the removal of millions of gallons of water per day; there is a D & D built pump for the job.

Trash pumps are available in sizes 3" through 18".

TRASH PUMP SPECIFICATIONS

Size	Weight Lbs / Kg	Volume Cu Ft / Cu Mtr	Capacity @ 20'-6.1 Mtr G.P.M./Ltr P.M	Required Hydraulic Oil GPM	Power Unit Required	Horse-Power
3LT	50/23	2.2/.06	450/1.703	8	50	16
4LT	57/26	3.2/.09	700/2.649	10/12	60/75	19
4T	67/30	3.6/.10	710/2.687	12	100	22
6T	335/152	11.8/.33	1.700/6.434	18	250	40
8T	490/222	25.4/.72	2.975/10.882	44	400	65
10T	620/281	31.4/.90	4.400/16.654	61	600	89
12T	720/327	40.7/1.15	5.250/19.87[illegible]	80	700	119
18T	847/384	44.7/1.26	7.[illegible]00/26.873	86	800	146

TRASH IMPELLER

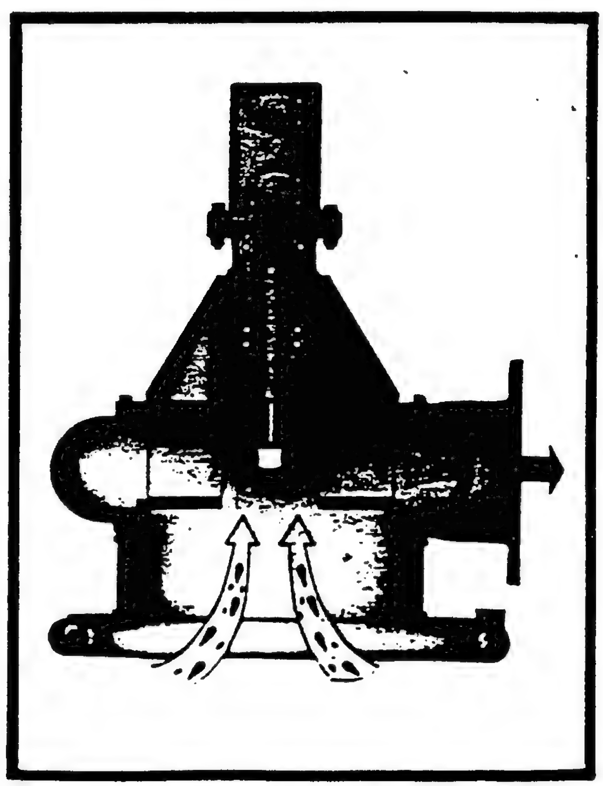
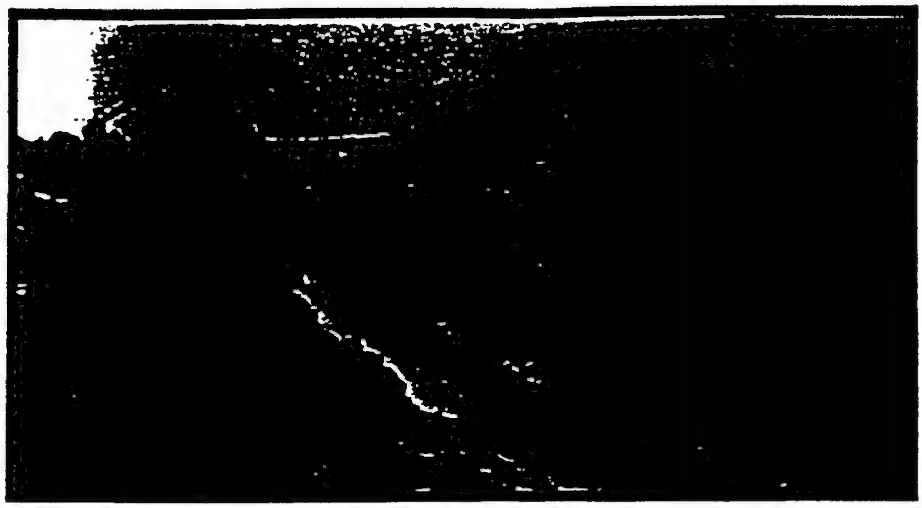


FIGURE 5

WHY HYDRAULIC SUBMERSIBLE TRASH PUMPS??

- Easy Setup
- Remote Portable Power Source
- Can Run Dry
- Regulate Flow
- No Priming Required
- Self-Monitoring Safety Shutdowns
- Multiple Pumps From One Power Unit
- Extreme Head Capabilities



APPLICATIONS

- **CONSTRUCTION •**
  Manhole - Sewer by Pass - Lakes - Canals - Pipe Laying - General Excavation
- **MINING •**
  Gravel Pits - Open Pit Mines
  Settling Ponds - Shaft Mines
- **AGRICULTURE •**
  Field Drying - Irrigation - Flood Control
  Livestock Watering

STANDARD FEATURES AND BENEFITS

- Special Hydraulic Motor
  Provides Bearing Lubrication
- Cast Steel Bearing Tube
  Oil Bath Bearing Lubrication
- 304 Stainless Steel Pump Shaft
  Long Pump Life
- Two Sets of Ball Bearings
  No Side Load Wear
- Cast Iron Volute and Impeller
  Uniform Performance
- #125 Discharge Flange
  Easy Connection
- Lifting Bale
  Easy to Move
- Inlet Screen
  Keeps Out Oversized Objects
- Spin on Hydraulic Connectors
  Fast Setup

OPTIONS

- Epoxy Coating
- All Stainless Steel Pump
- Discharge Flange to Pipe Adapter 90° - straight

Corp. & Mfg Facilities
D&D Machine & Hydraulics, Inc.
10945 Metro Parkway, S E
Fort Myers, FL [illegible]
813-275-717[illegible] [illegible] 5350 FAX
Cable DD P[illegible] [illegible] 759033

DEWATERING DESIGNERS PUMPS

N.E. Regional Sales Office
Commercial Ave.
Hudson, N.H. 03051
603-886-0522
FAX 603-889-6379

FIGURE 6

CHASKA MOIST SOIL UNIT							
	MOIST SOIL UNIT CELLS						
ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	CONTINGENCIES PERCENT
06.3.–.–	WILDLIFE FACILITIES						
06.3.–.–	MOB., DEMOB., PREP.,	JOB	1	6,000.00	6,000.00	600	10.00%
06.3.3.B	STRIPPING	CY	13,084	0.25	3,300.00	700	20.00%
06.3.3.B	EXCAVATION	CY	4,422	2.25	9,900.00	3,000	30.00%
06.3.3.B	DREDGING	CY	30	21.50	600.00	400	65.00%
06.3.3.B	IMPERVIOUS FILL	CY	12,858	3.07	39,500.00	11,900	30.00%
06.3.3.B	AGGREGATE BASE COURSE	CY	794	9.70	7,700.00	1,500	20.00%
06.3.3.B	BEDDING	CY	26	24.40	600.00	200	25.00%
06.3.3.B	RIPRAP	CY	44	36.00	1,600.00	400	25.00%
06.3.3.B	SURGE ROCK	CY	1,398	27.65	38,700.00	9,700	25.00%
06.3.3.B	DRAINAGE FILL	CY	5	22.30	100.00	0	0.00%
06.3.3.B	TOPSOIL	CY	7,895	10.70	84,500.00	25,400	30.00%
06.3.3.B	SEEDING	ACR	2	1,950.00	3,900.00	800	20.00%
06.3.3.B	CONTROL STRUCTURE NO. 2	JOB	1	6,400.00	6,400.00	1,900	30.00%
06.3.3.B	CONTROL STRUCTURE NO. 3	JOB	1	6,400.00	6,400.00	1,900	30.00%
06.3.3.B	CONTROL STRUCTURE NO. 4	JOB	1	4,600.00	4,600.00	1,400	30.00%
06.3.3.B	CONCRETE WALL	JOB	1	2,500.00	2,500.00	800	30.00%
06.3.4.Q	MECHANICAL	JOB	1	26,000.00	26,000.00	6,500	25.00%
	TOTAL ESTIMATE COST				242,300		
	CONTINGENCIES			27.7%		67,100	
	TOTAL ESTIMATED COST AND CONTINGENCIES					309,400	
	CHASKA LAKE DITCH						
06.3.–.–	WILDLIFE FACILITIES						
06.3.1.–	MOB., DEMOB., PREP.,	JOB	1	1,000.00	1,000.00	100	10.00%
06.3.3.B	CLEARING AND GRUBBING	ACR	0.50	3,250.00	1,600.00	300	20.00%
06.3.3.B	STRIPPING	CY	736	3.10	2,300.00	500	20.00%
06.3.3.B	EXCAVATION	CY	3,275	1.25	4,100.00	1,200	30.00%
06.3.3.B	DREDGING	CY	275	17.30	4,800.00	2,900	60.00%
06.3.3.B	IMPERVIOUS FILL	CY	40	5.30	200.00	100	30.00%
06.3.3.B	AGGREGATE BASE COURSE	CY	38	10.75	400.00	100	25.00%
06.3.3.B	BEDDING	CY	75	22.60	1,700.00	400	25.00%
06.3.3.B	RIPRAP	CY	147	32.40	4,800.00	1,200	25.00%
06.3.3.B	TOPSOIL	CY	70	6.95	500.00	200	30.00%
06.3.3.B	SEEDING	ACR	0.13	1,950.00	300.00	100	30.00%
06.3.4.Q	CONTROL STRUCTURE NO. 1	JOB	1	9,100.00	9,100.00	2,700	30.00%
	TOTAL ESTIMATED COST				31,000		
	CONTINGENCIES			32.26%		10,000	
	TOTAL ESTIMATED COST AND CONTINGENCIES					41,000	
	TOTAL WILDLIFE FACILITIES					$350,000	

ATTACHMENT 1

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Minnesota Valley National Wildlife Refuge
3815 East 80th Street
Bloomington, Minnesota 55425-1600

TAKE PRIDE IN AMERICA

April 27, 1993

Memorandum

To: Dave Raasch, Project Management Office, Army Corps of Engineers

From: Refuge Manager, Minnesota Valley National Wildlife Refuge

Subject: Comments on Latest Chaska Flood Control Mitigation Design

The latest plans appeared very thorough and most the items agreed upon during the cooperative effort over the years were incorporated.

The following items were not clearly defined and need to be confirmed:

Page 4.17-This paragraph is interpreted as intending that all dikes will be 3 to 1 slopes. Our notes and recollection are that only riprapped dikes would have 3 to 1 slopes and unriprapped would be sloped 4 or 5 to 1. Drawing # M34-CH-R-5/236 in the note section reads 5 to 1. We have recently purchased equipment that will allow us to mow dikes without taking equipment on the slope. We now propose that 4 to 1 slopes on unriprapped dikes would be preferred as it would reduce damage from burrowing animals and our mowing equipment will reach the toe of the dike.

Page 8.35-The third sentence in this paragraph states that riprap is recommended at the entrance and exit. Terry M. Schreiner reported that it was decided during a conference phone conversation on 1/28/93 with you and other staff that riprap would definitely be needed at both ends of this structure. We strongly believe that this area needs protection.

I would like to take this opportunity to commend you and all the staff involved in this project over the years. The communication and working relationships have been excellent. This kind of cooperative effort can only improve our collective future efforts.

Thomas J. Larson

Thomas J. Larson

cc: Gary Wege, Twin Cities Field Office

ATTACHMENT 2

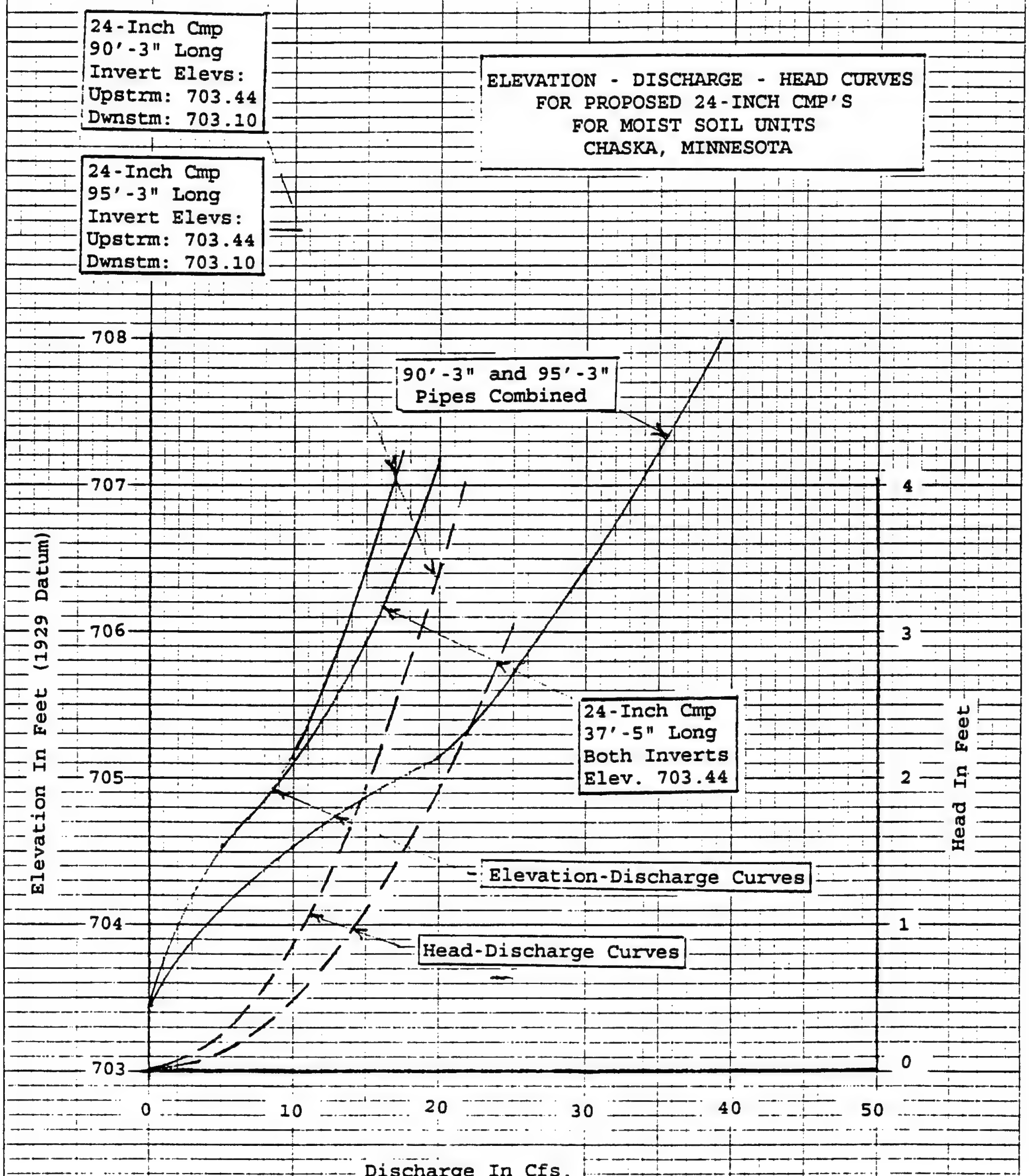

24-Inch Cmp
90'-3" Long
Invert Elevs:
Upstrm: 703.44
Dwnstm: 703.10
24-Inch Cmp
95'-3" Long
Invert Elevs:
Upstrm: 703.44
Dwnstm: 703.10
ELEVATION - DISCHARGE - HEAD CURVES
FOR PROPOSED 24-INCH CMP'S
FOR MOIST SOIL UNITS
CHASKA, MINNESOTA
90'-3" and 95'-3"
Pipes Combined
24-Inch Cmp
37'-5" Long
Both Inverts
Elev. 703.44
Elevation-Discharge Curves
Head-Discharge Curves
Elevation In Feet (1929 Datum)
Head In Feet
Discharge In Cfs.
708
707
706
705
704
703
4
3
2
1
0
0
10
20
30
40
50

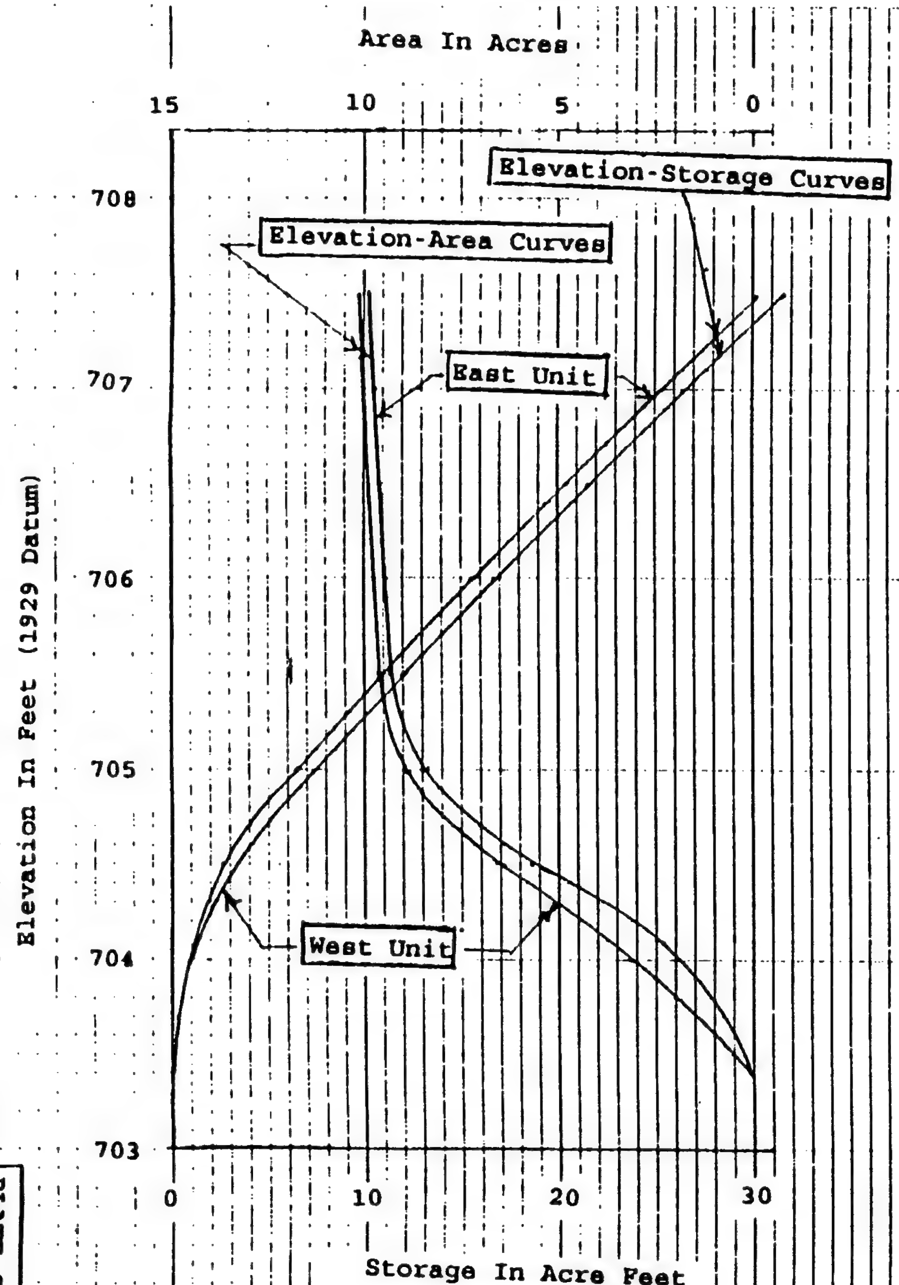
PLATE S-1

46 0700

ELEVATION - AREA - STORAGE CURVES

MOIST SOIL UNITS AND CHASKA LAKE

CHASKA, MINNESOTA



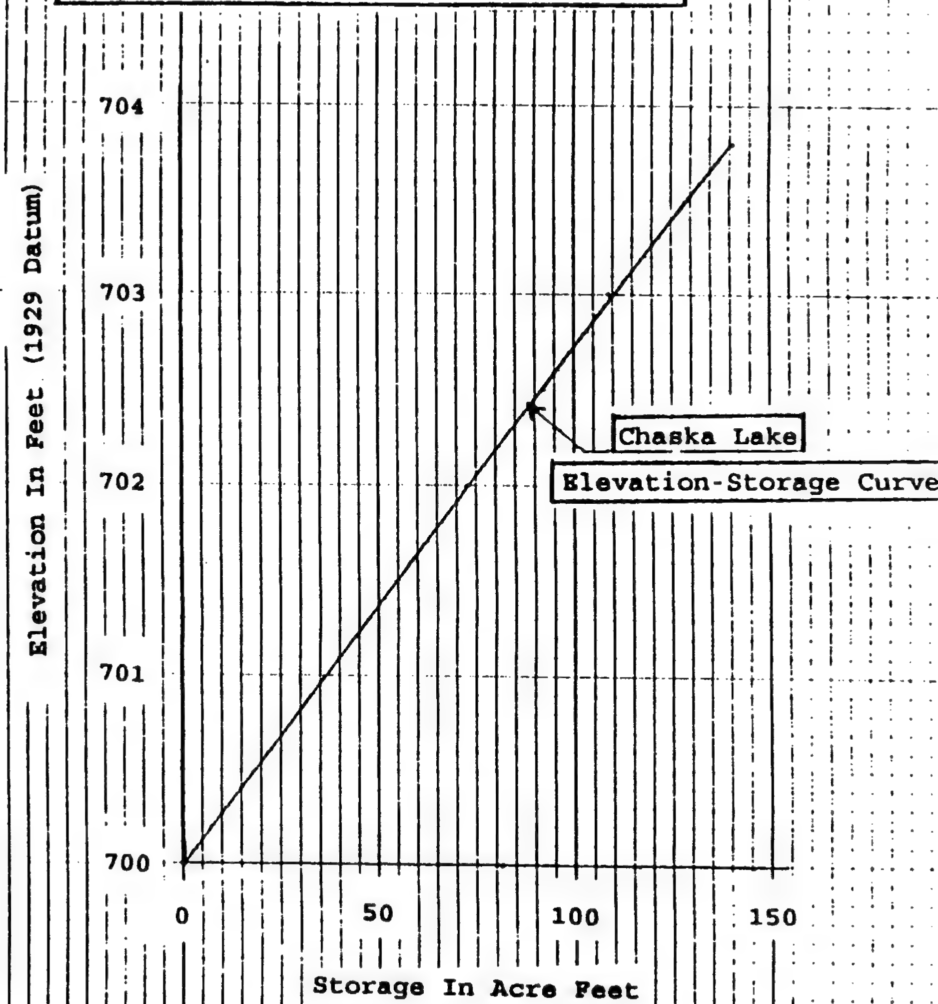


PLATE S-2

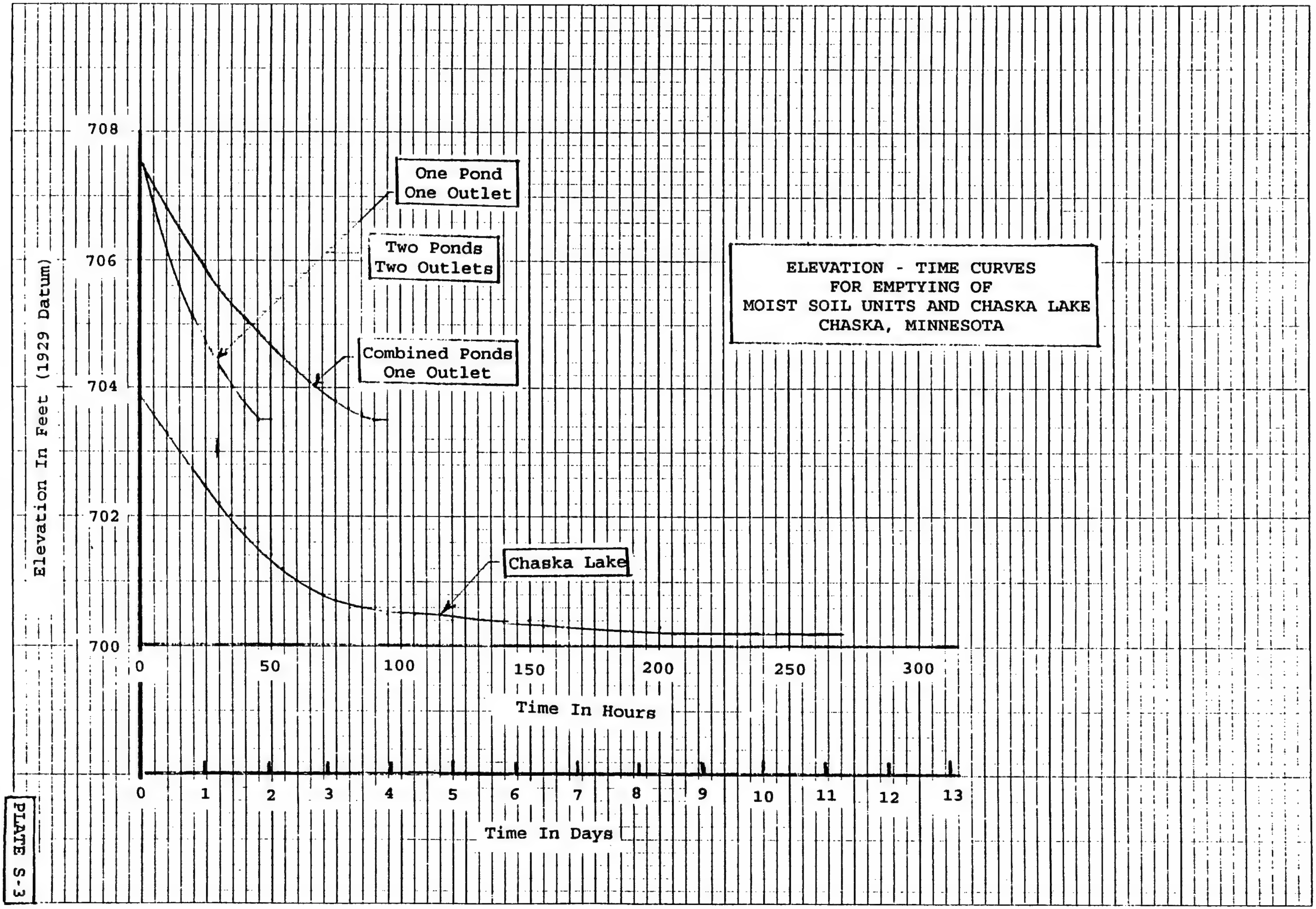

ELEVATION - TIME CURVES
FOR EMPTYING OF
MOIST SOIL UNITS AND CHASKA LAKE
CHASKA, MINNESOTA
One Pond
One Outlet
Two Ponds
Two Outlets
Combined Ponds
One Outlet
Chaska Lake
Elevation In Feet (1929 Datum)
708
706
704
702
700
0
50
100
150
200
250
300
Time In Hours
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Time In Days

PLATE S-3

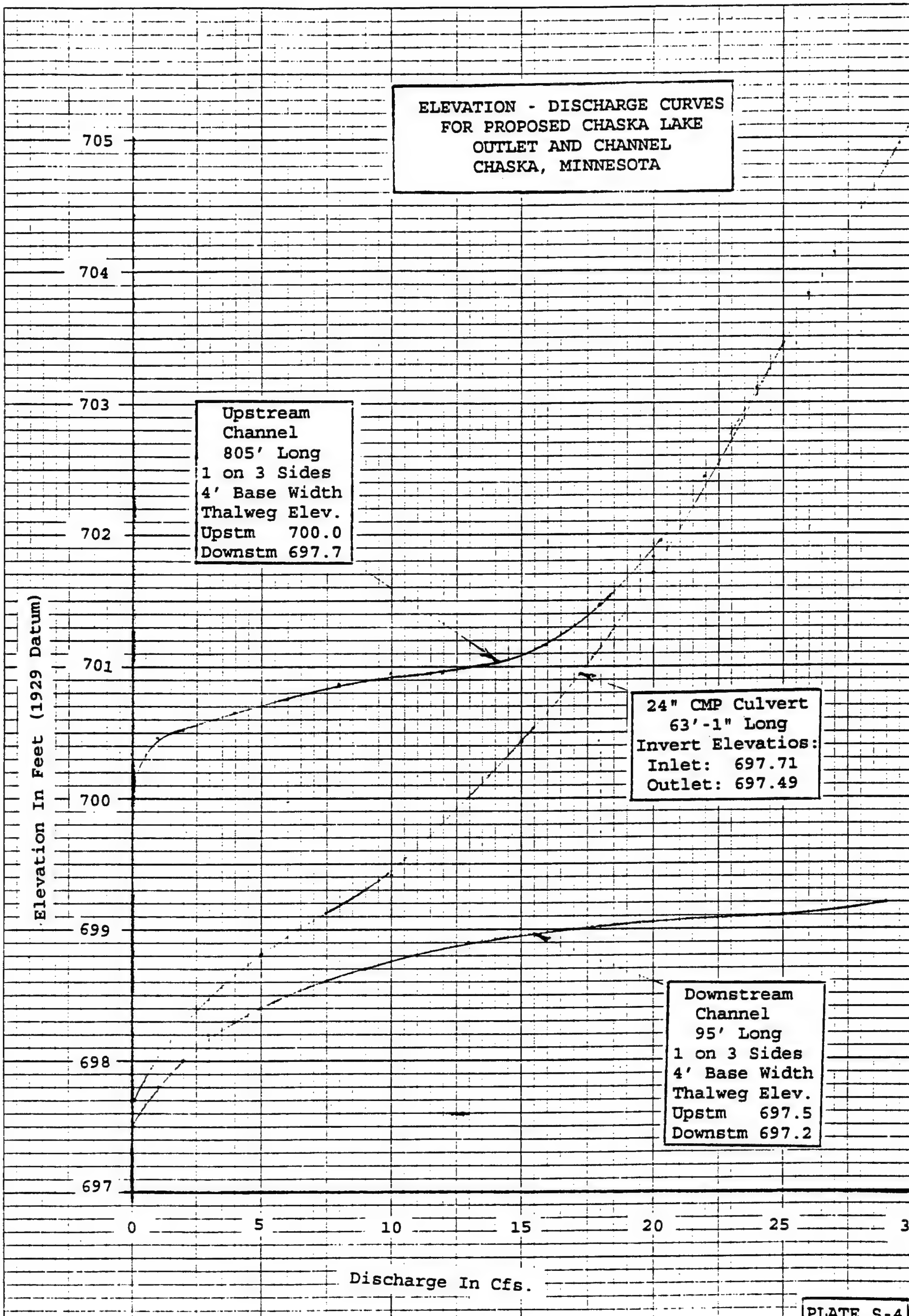
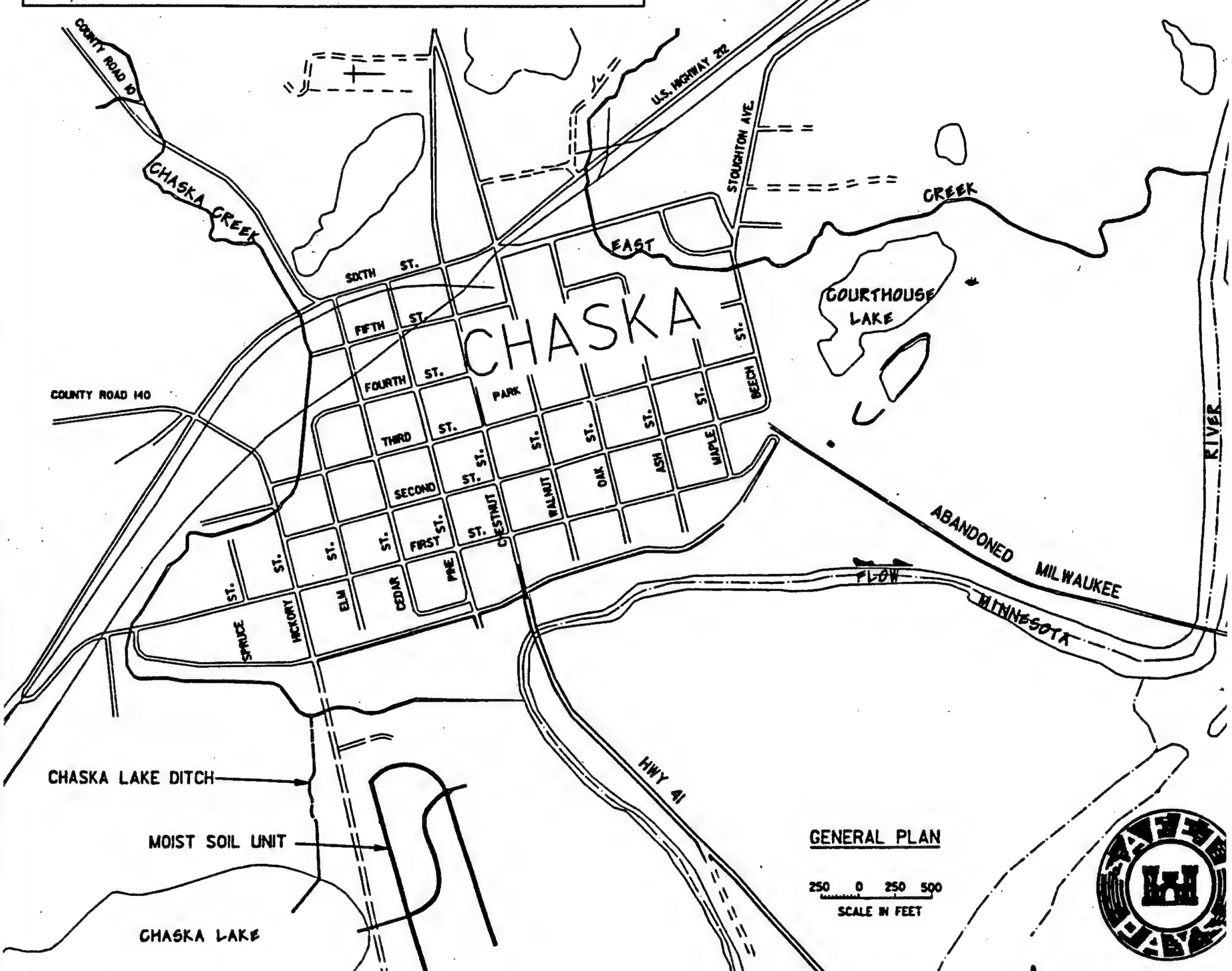
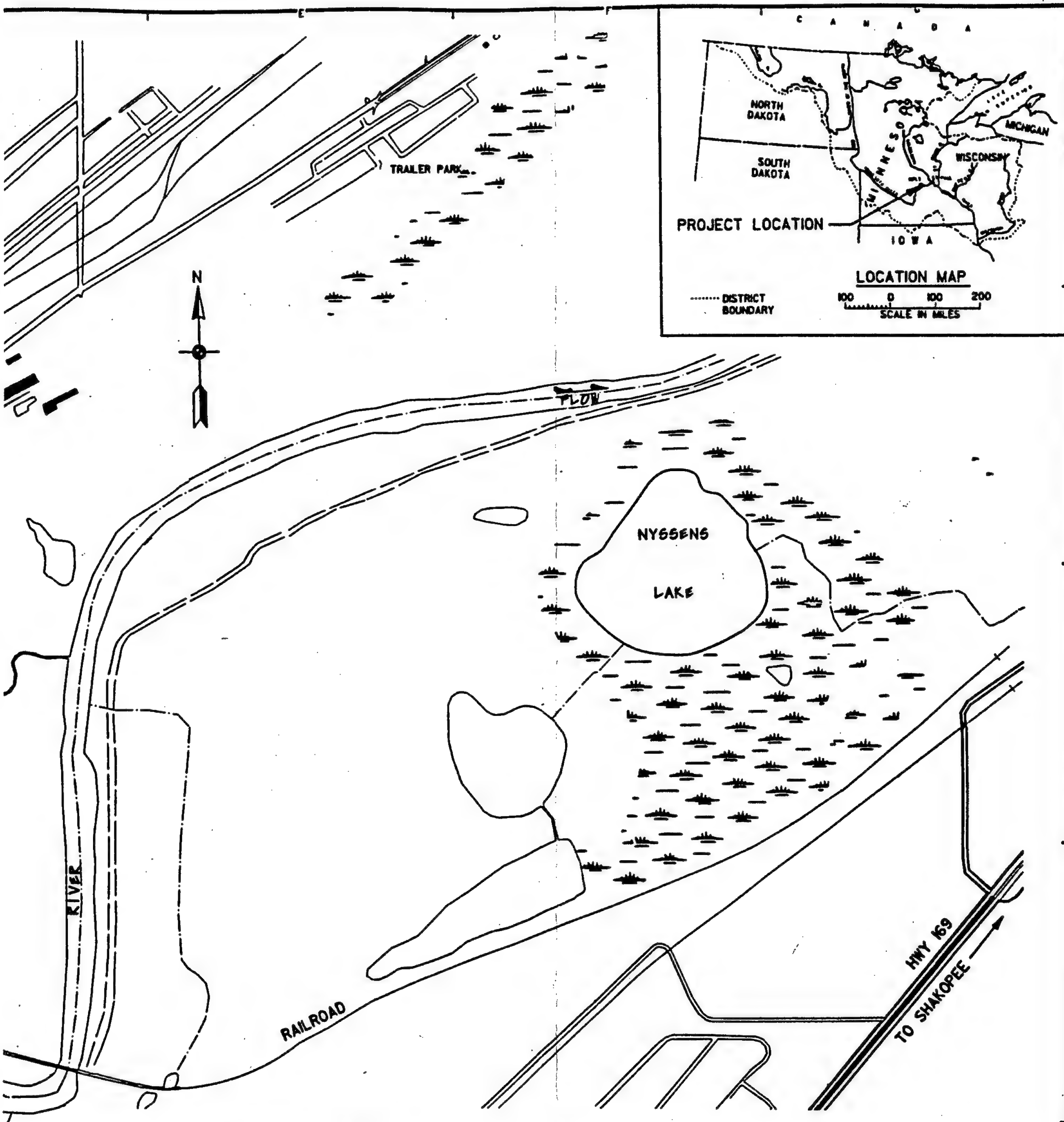

ELEVATION - DISCHARGE CURVES
FOR PROPOSED CHASKA LAKE
OUTLET AND CHANNEL
CHASKA, MINNESOTA
Upstream
Channel
805' Long
1 on 3 Sides
4' Base Width
Thalweg Elev.
Upstm 700.0
Downstm 697.7
24" CMP Culvert
63'-1" Long
Invert Elevatios:
Inlet: 697.71
Outlet: 697.49
Downstream
Channel
95' Long
1 on 3 Sides
4' Base Width
Thalweg Elev.
Upstm 697.5
Downstm 697.2
705
704
703
702
701
700
699
698
697
Elevation In Feet (1929 Datum)
0
5
10
15
20
25
30
Discharge In Cfs.

PLATE S-4

DRAWING INDEX		
DRAWING NO.	SHT.	DESCRIPTION
M34-CH-R-5/232	1	LOCATION MAP, GENERAL PLAN, AND DRAWING INDEX
M34-CH-R-5/233	2	BORING LOGS, GEN. NOTES, BORING LEGEND, LOGS 83-53M, 89-127M - 89-129M
M34-CH-R-5/234	3	BORING LOGS 91-149M THRU 91-152M
M34-CH-R-5/235	4	BORING LOGS 91-153M THRU 91-157M
M34-CH-R-5/236	5	CONTROL STRUCTURE GENERAL PLAN
M34-CH-R-5/237	6	DIKE, ISLAND, AND DITCH CROSS SECTIONS
M34-CH-R-5/238	7	CONTROL STRUCTURES PROFILES
M34-CH-R-5/239	8	CONTROL STRUCTURES AND PLATFORMS PLAN, ELEVATIONS, SECTIONS AND DETAIL
M34-CH-R-5/240	9	INLET PORTABLE PUMP, CRANE AND WALL PLAN, ELEVATION, SECTION AND DIAGRAM





SIGNATURES AFFIXED BELOW INDICATE OFFICIAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS IN THIS SET, AS INDEXED ON THIS SHEET.

APPROVAL RECOMMENDED BY:

CHIEF	ED-D	BRANCH
CHIEF	ED-GH	BRANCH
CHIEF	ENGINEERING	DIVISION

APPROVED BY:

COL., CORPS OF ENGINEERS

ENGINEER MANAGER

CHIEF SPECS. & TECH. SUPPORT SECTION

CHIEF GENERAL ENGINEERING SECTION

CHIEF STRUCTURAL SECTION

CHIEF MECH/ELEC/ARCH SECTION

CHIEF HYDRAULICS SECTION

CHIEF HYDROLOGY SECTION

CHIEF GEOTECHNICAL DESIGN SECTION

	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

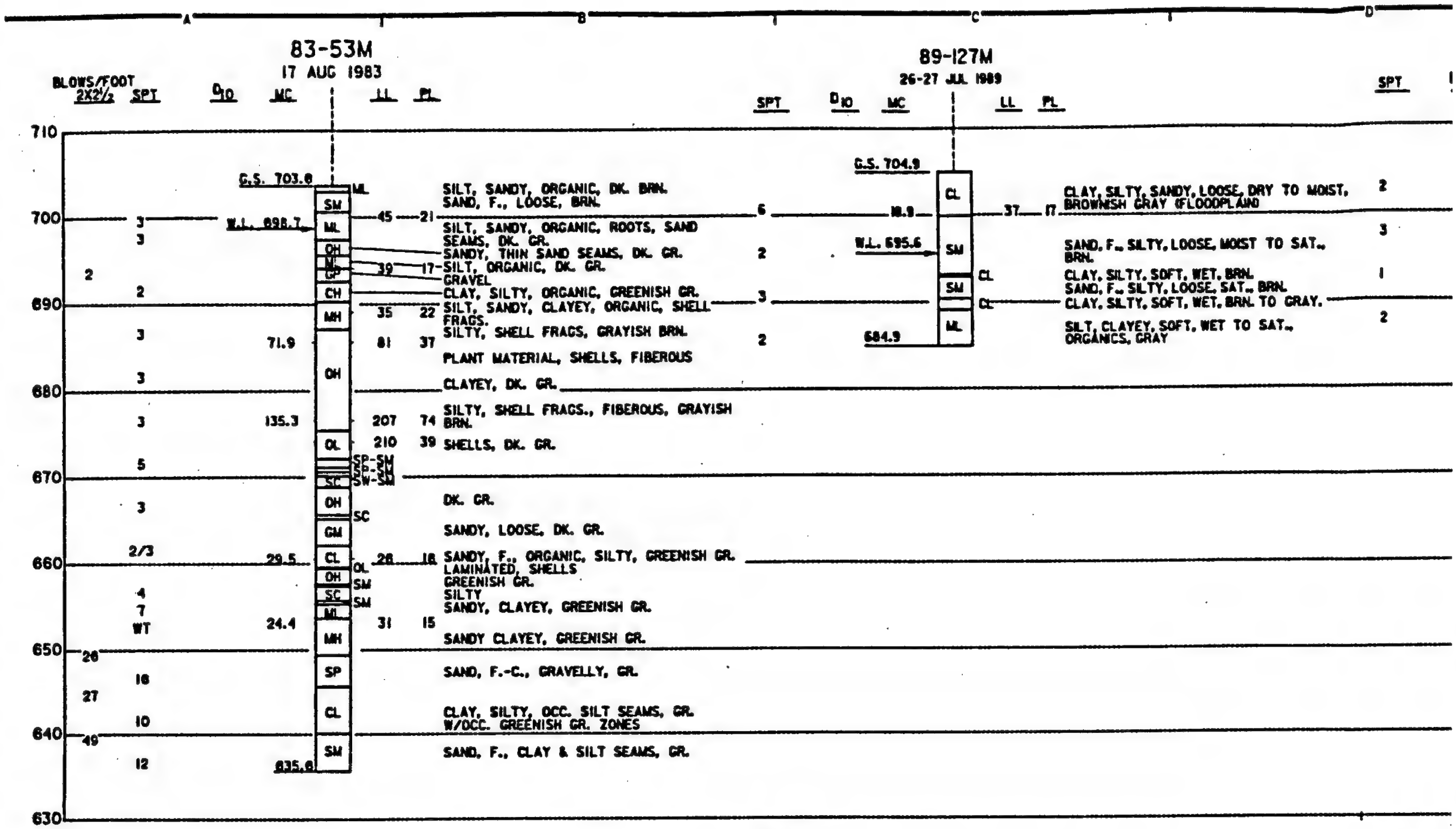
ED-D	DESIGNED:	M.M.B.
	CHECKED:	
	DRAWN:	T.J.
ED-GH	DESIGNED:	W.J.M.-J.R.C.
	CHECKED:	
DATE:	MARCH 10, 1993	

DESIGN MEMORANDUM NO. 2 - SUPPLEMENT NO. 1
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA

MOIST SOIL UNIT AND CHASKA LAKE
LOCATION MAP, GENERAL PLAN AND DRAWING INDEX

CAD FILE NAME: MSUCOV.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/232
SHT 1 OF 9

2



NOTES:

1. WATER LEVEL DETERMINED AFTER 15 HOURS WITH: BOTTOM OF AUGER AT EL. 689.9' BOTTOM OF HOLE AT EL. 689.8' AFTER SAMPLING TO EL. 684.9'
2. HOLLOW STEM AUGER WAS NOT ADVANCED FURTHER.
3. BACKFILLED HOLE WITH CEMENT-WATER MIXTURE AND NATURAL MATERIALS.

NOTES:

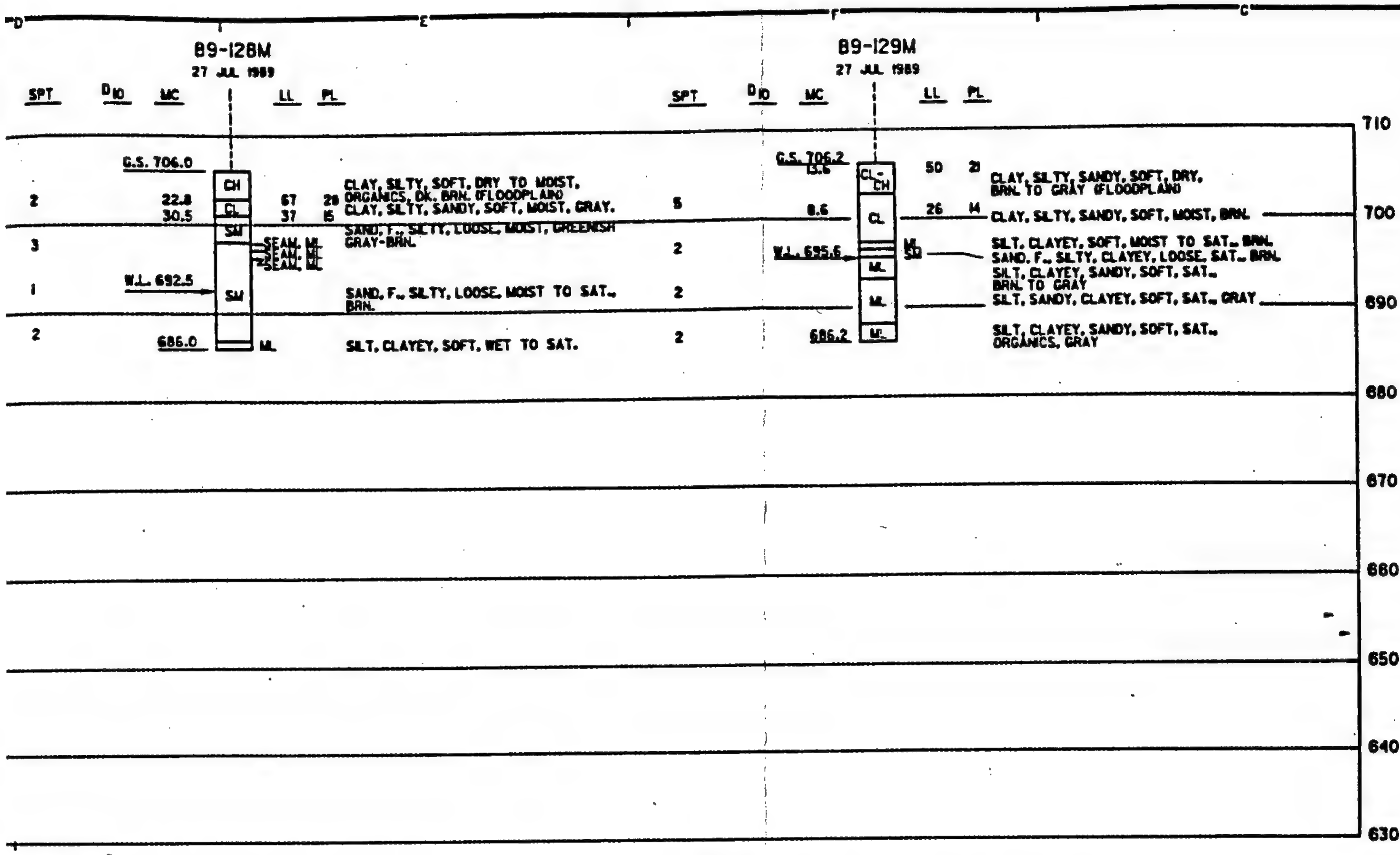
1. WATE
2. HOLL
3. BACI NATI

GENERAL BORING LEGEND

84-1M	YEAR OF BORING-BORING NUMBER, BORING TYPE (EG: M=MACHINE, A=AUGER, TP=TEST PIT, P=PIEZOMETER).
1 MAY 1984	DATE OF BORING
G.S. 1020.2	GROUND SURFACE ELEVATION AT BORING
GW	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURE, LITTLE OR NO FINES
GP	POORLY GRADED GRAVELS, LITTLE OR NO FINES
GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SM	SILTY SANDS, SAND - SILT MIXTURES
SC	CLAYEY SANDS, SAND - CLAY MIXTURES
ML	INORGANIC SILTS, LIQUID LIMIT LESS THAN 50
MH	INORGANIC SILTS, LIQUID LIMIT GREATER THAN 50
CL	INORGANIC CLAYS, LOW TO MEDIUM PLASTICITY, LIQUID LIMIT LESS THAN 50
CH	INORGANIC CLAYS, HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
OL	ORGANIC SILTS OR CLAYS, LOW PLASTICITY, LIQUID LIMIT LESS THAN 50
OH	ORGANIC SILTS OR CLAYS, MEDIUM TO HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
PT	PEAT
SP-SM	BORDERLINE MATERIAL
SP& SM	STRATIFIED MATERIAL
1	LOCATION AND SAMPLE NUMBER FOR UNDISTURBED SAMPLE
	NO RECOVERY
W.L. 726.7	WATER LEVEL ON DATE OF BORING
700	ELEVATION AT BOTTOM OF BORING

GENERAL BORING NOTES

1. GENERAL: THE UNIFIED SOIL CLASSIFICATION REPRESENTS ONLY THE BASIC SOIL IS ADDED TO THE RIGHT OF THE B SHOWN BELOW THE BORING STAFF.
2. MOISTURE CONTENT: THE NATURAL MOISTURE CONTENT I THE BORING STAFF.
3. BLOW COUNT (SPT): BLOW COUNTS ARE SHOWN TO THE OF BLOWS NECESSARY TO DRIVE T ARE FOR A STANDARD PENETRATION DROP. FOR NON-STANDARD BLOW C ARE AS SHOWN.
4. ATTERBERG LIMITS: LIQUID LIMIT (LL) AND PLASTIC L
5. D_{10} SIZE: THE GRAIN SIZE IN MILLIMETERS O OF THE BORING STAFF.



NOTES:

1. WATER LEVEL DETERMINED AFTER 75 MINUTES WITH:
   BOTTOM OF AUGER AT EL. 691.0
   BOTTOM OF HOLE AT EL. 690.8
   AFTER SAMPLING TO EL. 686.0
2. HOLLOW STEM AUGER WAS NOT ADVANCED FURTHER.
3. BACKFILLED HOLE WITH CEMENT-WATER MISTURE AND NATURAL MATERIALS.

NOTES:

1. WATER LEVEL DETERMINED AFTER 90 MINUTES WITH:
   BOTTOM OF AUGER AT EL. 691.2
   BOTTOM OF HOLE AT EL. 690.5
   AFTER SAMPLING TO EL. 686.2
2. HOLLOW STEM AUGER WAS NOT ADVANCED FURTHER.
3. BACKFILLED HOLE WITH CEMENT-WATER MIXTURE AND NATURAL MATERIALS.

ES

ASSIFICATION SYSTEM IS USED TO IDENTIFY BASIC SOIL TYPE. THE LEGEND
E BASIC SOILS. TO COMPLETE THE CLASSIFICATION, PERTINENT INFORMATION
HT OF THE BORING STAFF. NOTES PERTAINING TO A SPECIFIC BORING ARE
RING STAFF.

RE CONTENT IN PERCENT OF DRY WEIGHT (MC) IS SHOWN TO THE LEFT OF

HOWN TO THE LEFT OF THE BORING STAFF AND, EXCEPT AS NOTED, ARE THE NUMBER
' TO DRIVE THE SAMPLER USED A DISTANCE OF 12". STANDARD BLOW COUNTS
) PENETRATION TEST (SPT) USING A 1-3/8" X 2" SAMPLER, 140 LB. HAMMER AND A 30"
DARD BLOW COUNTS, SAMPLER SIZE, HAMMER WEIGHT AND HEIGHT OF DROP

ND PLASTIC LIMIT (PL) ARE SHOWN TO THE RIGHT OF THE BORING STAFF.

ILLIMETERS OF WHICH 10% OF THE SAMPLE IS FINER IS SHOWN TO THE LEFT
F.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2 - SUPPLEMENT NO. 1
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT — CHASKA, MINNESOTA

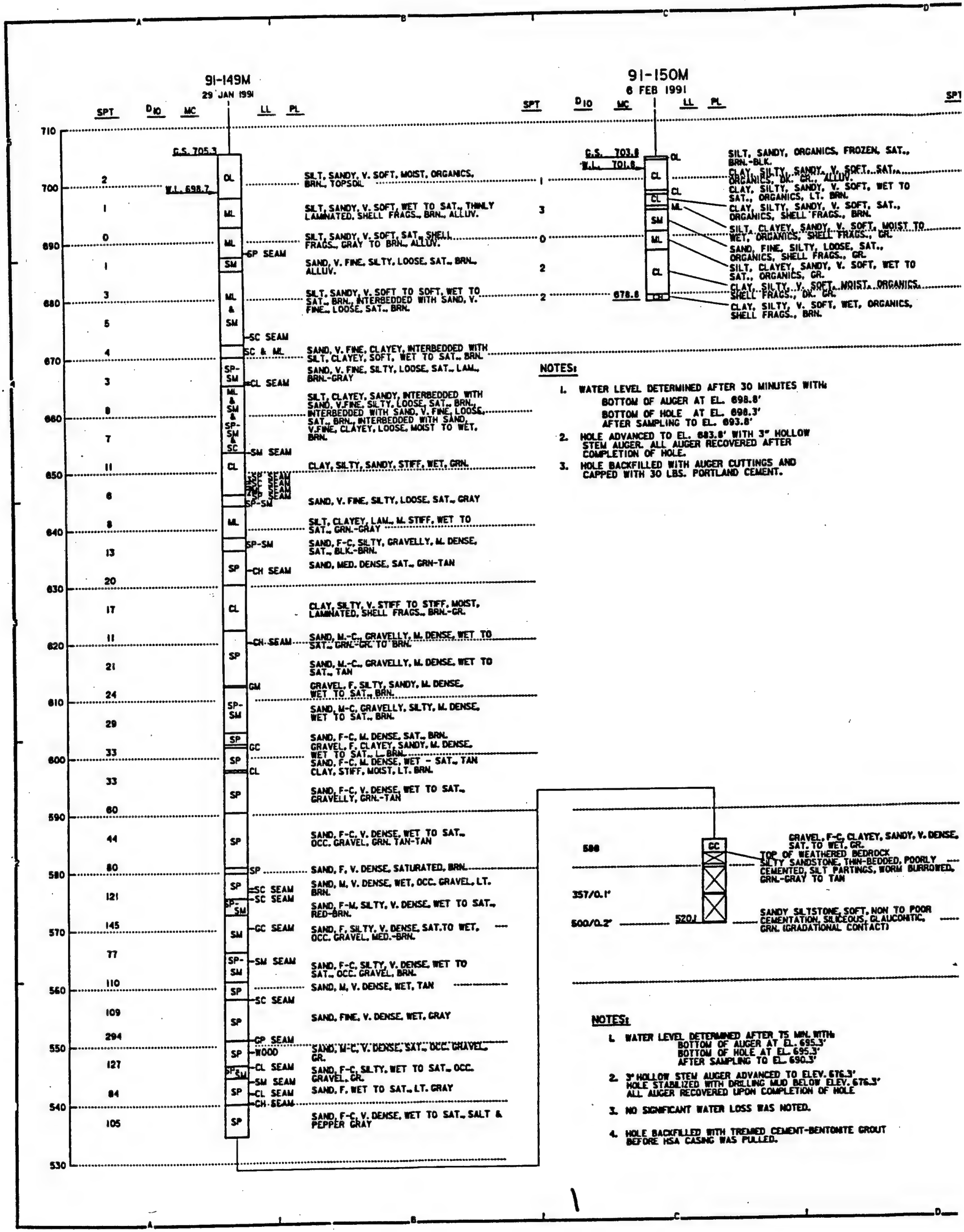
MOIST SOIL UNIT AND CHASKA LAKE

BORING LOGS, GENERAL NOTES, BORING LEGEND, LOGS 83-53M, 89-127M THRU 89-129M

CO-D	DESIGNED:	
	CHECKED:	
	DRAWN:	GRS
CO-E	DESIGNED:	JRC/PAW
	CHECKED:	
DATE: March 8, 1993		

CAD FILE NAME: NCIBR400.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/233
SHT 2 OF 9

2

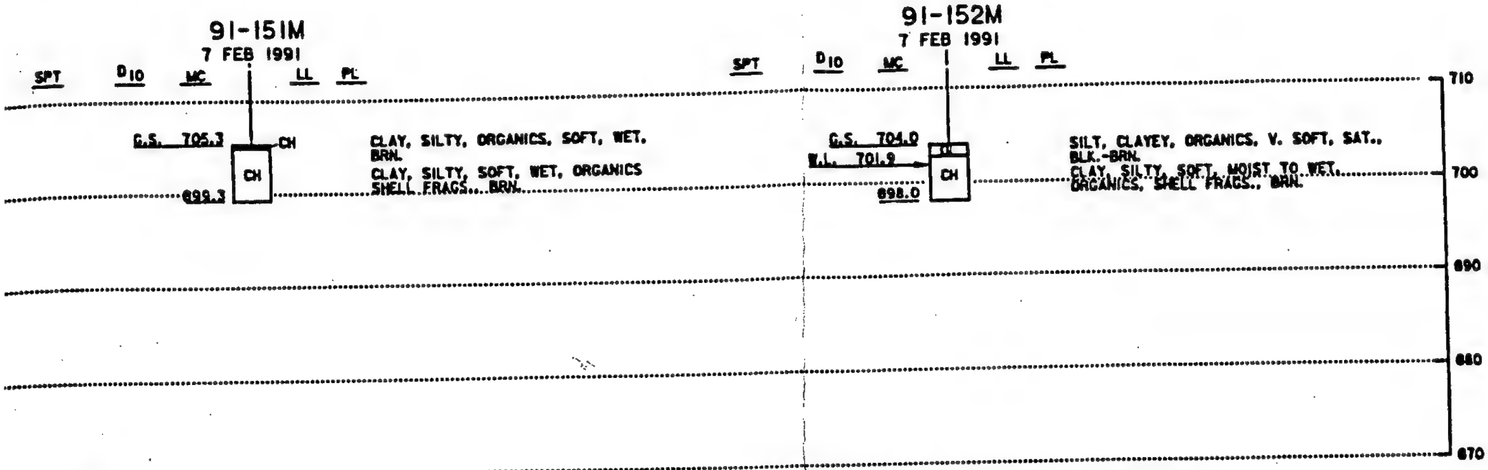


NOTES:

1. WATER LEVEL DETERMINED AFTER 30 MINUTES WITH:
   BOTTOM OF AUGER AT EL. 698.8'
   BOTTOM OF HOLE AT EL. 698.3'
   AFTER SAMPLING TO EL. 693.8'
2. HOLE ADVANCED TO EL. 683.8' WITH 3" HOLLOW STEM AUGER. ALL AUGER RECOVERED AFTER COMPLETION OF HOLE.
3. HOLE BACKFILLED WITH AUGER CUTTINGS AND CAPPED WITH 30 LBS. PORTLAND CEMENT.

NOTES:

1. WATER LEVEL DETERMINED AFTER 75 MIN. WITH:
   BOTTOM OF AUGER AT EL. 695.3'
   BOTTOM OF HOLE AT EL. 695.3'
   AFTER SAMPLING TO EL. 690.3'
2. 3" HOLLOW STEM AUGER ADVANCED TO ELEV. 676.3'. HOLE STABILIZED WITH DRILLING MUD BELOW ELEV. 676.3'. ALL AUGER RECOVERED UPON COMPLETION OF HOLE.
3. NO SIGNIFICANT WATER LOSS WAS NOTED.
4. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT BEFORE HSA CASING WAS PULLED.

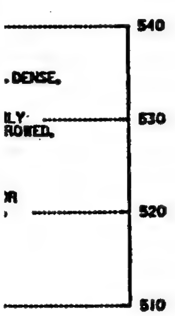


NOTES:

1. WATER LEVEL AND STANDARD PENETRATION NOT DETERMINED. HOLE FILLED WITH SURFACE WATER.
2. NO CASING SET.
3. HOLE BACKFILLED WITH BENTONITE.

NOTES:

1. WATER LEVEL DETERMINED AFTER 5.5 HOURS WITH NO CASING USED AND BOTTOM OF HOLE AT EL. 701.3' AFTER SAMPLING TO EL. 698.0'.
2. STANDARD PENETRATION NOT DETERMINED.
3. HOLE BACKFILLED WITH BENTONITE.



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

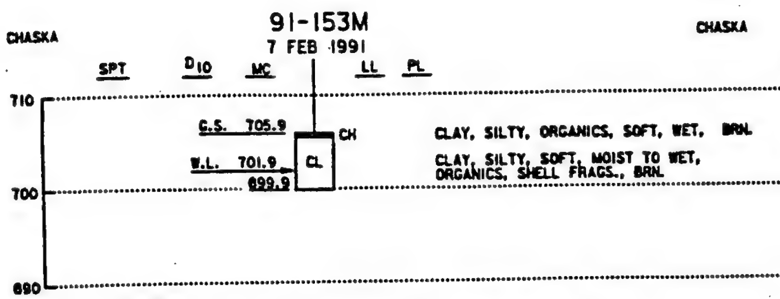
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2 - SUPPLEMENT NO. 1
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT — CHASKA, MINNESOTA
MOIST SOIL UNIT AND CHASKA LAKE
BORING LOGS 91-149M THRU 91-152M

ED-D: DESIGNED: / CHECKED: / DRAWN: CRS
ED-GH: DESIGNED: PAW/JRC / CHECKED:
DATE: MARCH 8, 1993

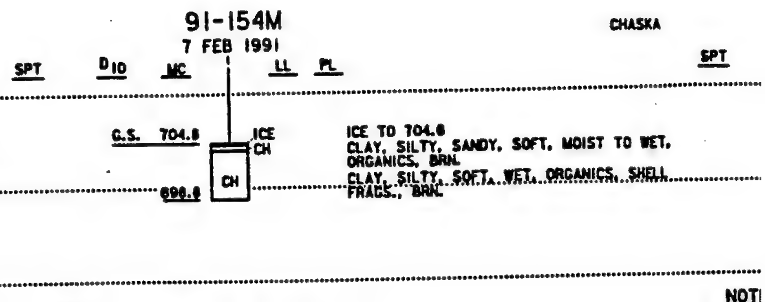
CAD FILE NAME: NC18R401.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/234
SHT 3 OF 9

2



NOTES:

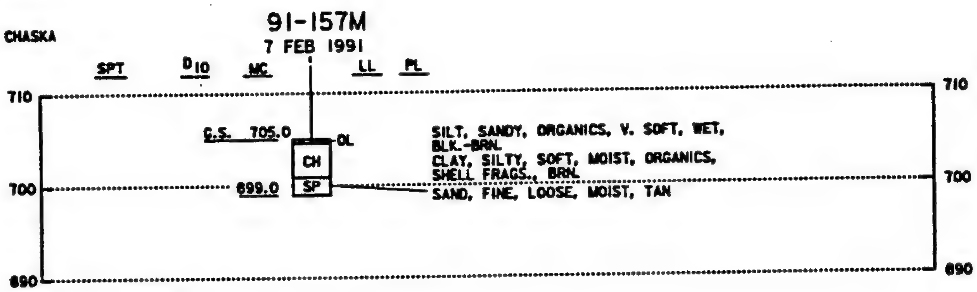
1. WATER LEVEL DETEMINED AFTER 5 HOURS WITH NO CASING USED AND BOTTOM OF HOLE AT EL. 701.0', AFTER SAMPLING TO EL. 699.9.
2. STANDARD PENETRATION TEST NOT DETERMINED.
3. HOLE BACKFILLED WITH BENTONITE.



NOTES:

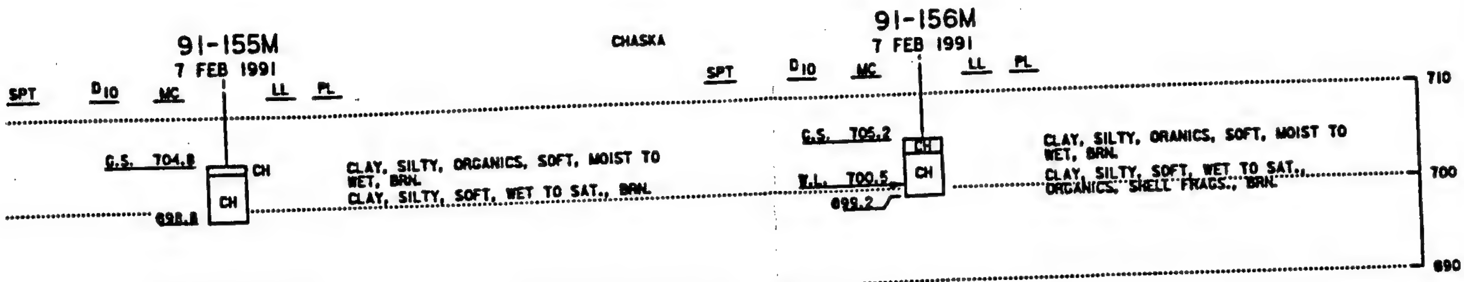
1. WATER LEVEL NOT DETERMINED.
2. STANDARD PENETRATION NOT DETERMINED.
3. HOLE BACKFILLED WITH BENTONITE.

NOT



NOTES:

1. WATER LEVEL NOT ENCOUNTERED.
2. SURVEYED ELEVATIONS ARE +1.0 FT.
3. NO HSA CASING INSTALLED.
4. HOLE BACKFILLED WITH BENTONITE.



NOTES:
1. WATER LEVEL NOT DETERMINED DUE TO SURFACE WATER RUNNING INTO HOLE.
2. STANDARD PENETRATION TEST NOT DETERMINED.
3. HOLE BACKFILLED WITH BENTONITE.

NOTES:
1. WATER LEVEL DETERMINED AFTER 90 MINUTES WITH NO CASING USED AND BOTTOM OF HOLE AT EL. 700.5'.
2. STANDARD PENETRATION TEST NOT DETERMINED.
3. HOLE BACKFILLED WITH BENTONITE.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2 - SUPPLEMENT NO. 1
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA

MOIST SOIL UNIT AND CHASKA LAKE

BORING LOGS 91-153M THRU 91-157M

ED-D	DESIGNED:	
	CHECKED:	
	DRAWN:	GRS
ED-GH	DESIGNED:	PAW/JRC
	CHECKED:	

DATE: MARCH 11, 1993

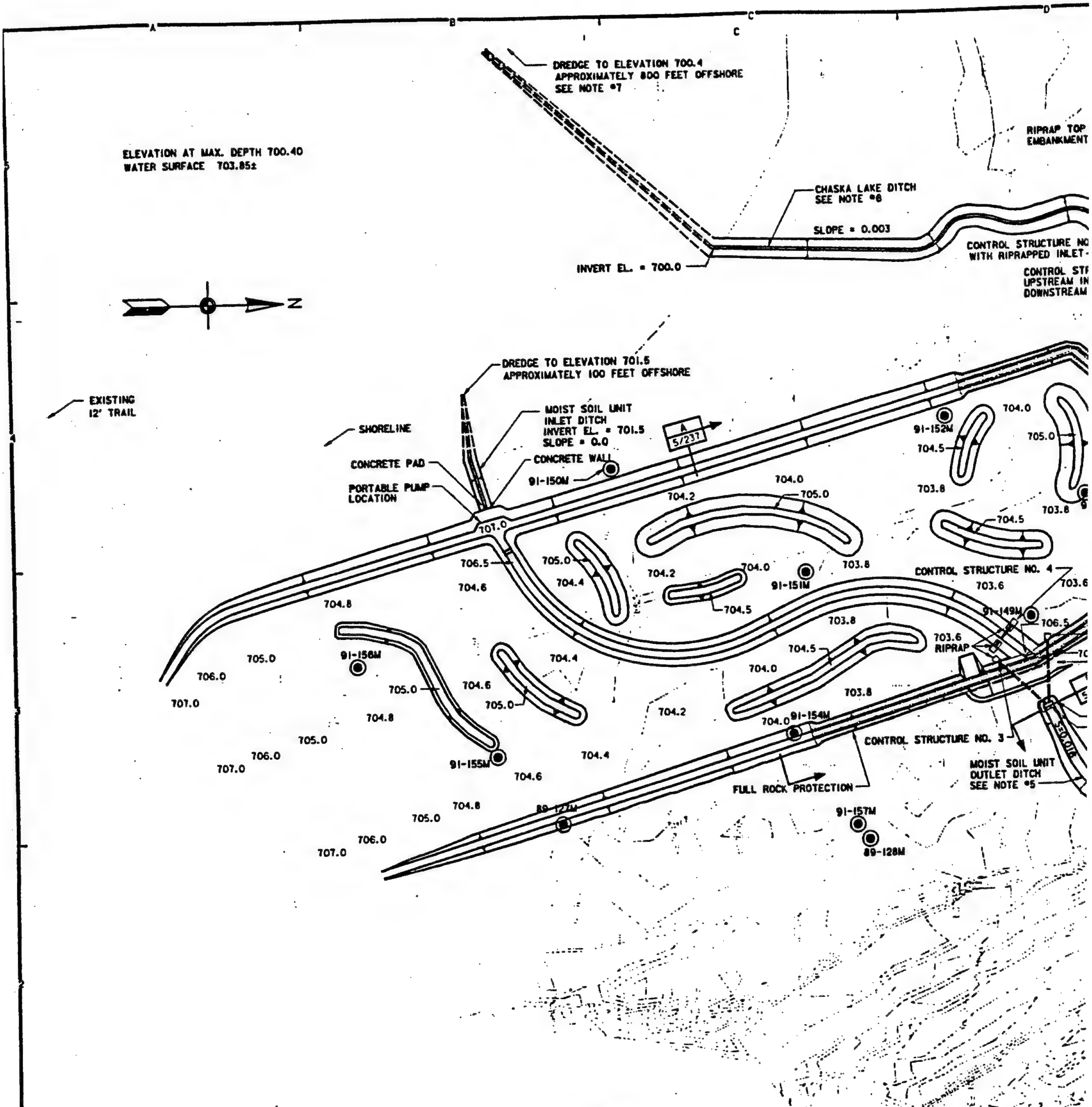
CAD FILE NAME: NC18R402.DGN

SPEC NO:

DRAWING NUMBER: M34-CH-R-5/235

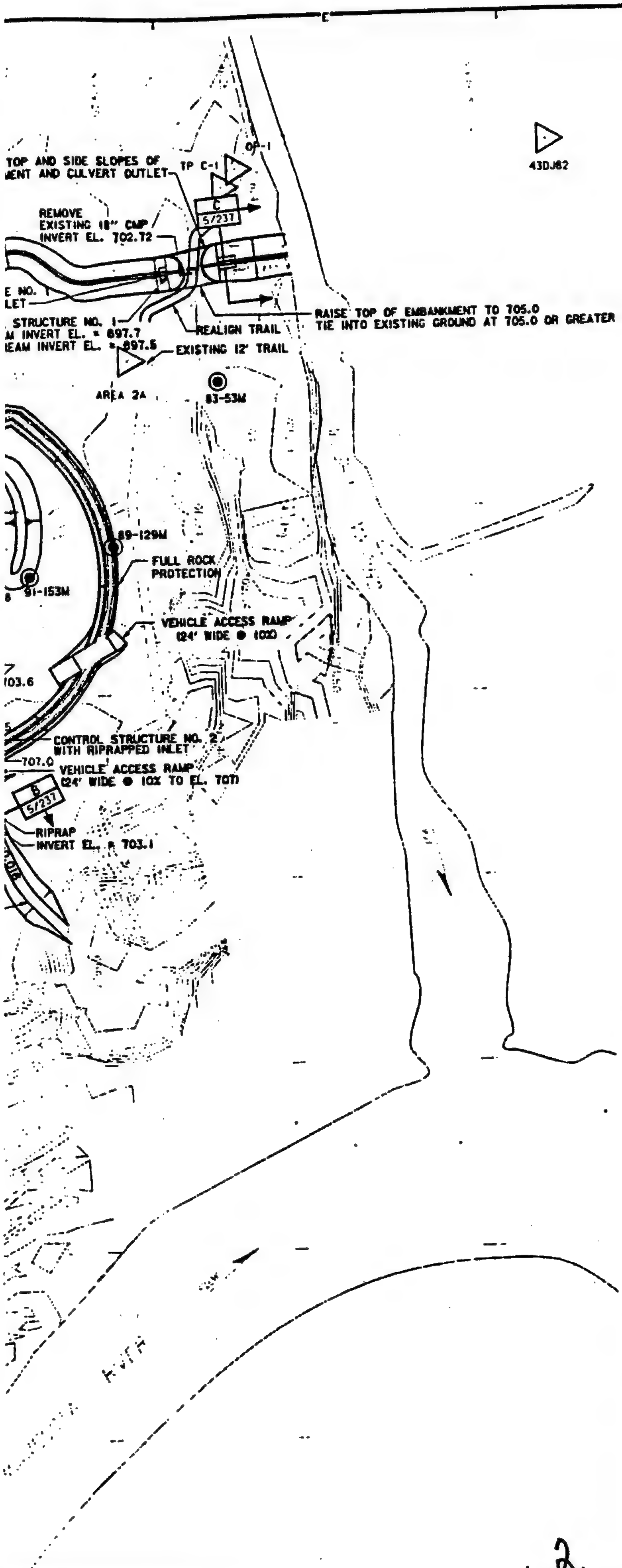
SHT 4 OF 9

2



PLAN

100 0 100 200
SCALE IN FEET



NOTES:

1. THE OUTSIDE LEVEE ELEVATION IS 707.0, THE INSIDE LEVEE ELEVATION IS 706.5, THE MAXIMUM DESIGN WATER SURFACE IS ELEVATION 705.5.
2. ALL ISLANDS HAVE 12' TOP WIDTHS AND 1V ON 20H SIDESLOPES.
3. ALL ELEVATIONS SHOWN ARE 1929 ADJUSTED.
4. ALL LEVEES HAVE 12' TOP WIDTHS. LEVEES PROTECTED WITH SURGE ROCK HAVE 1V ON 3H SIDE SLOPES. UNPROTECTED LEVEES HAVE 1V ON 5H SIDE SLOPES.
5. THE MOIST SOIL UNIT OUTLET DITCH HAS A 15' BASE WIDTH AND 1V ON 3H SLOPES.
6. THE CHASKA LAKE OUTLET DITCH HAS A 4' BASE WIDTH AND 1V ON 3H SLOPES.
7. CHASKA LAKE SHALL BE DREDGED SUCH THAT TWO TRAPEZOIDAL CHANNELS WITH 4' WIDE BASE WIDTHS WILL BE CONSTRUCTED. THE CHANNEL FOR DRAINING CHASKA LAKE WILL HAVE AN INVERT OF 700.4'. THE INVERT FOR THE MOIST SOIL UNIT INLET DITCH WILL BE 701.5'.

REFERENCES:

	DWG. NO.
1. CONTROL STRUCTURE	5/238
2. BORINGS	5/233,5/234

LEGEND:

703.66 - DENOTES PROPOSED ELEVATIONS

7..... - DENOTES EXISTING ELEVATIONS

TOP OF ISLAND

TOE OF ISLAND

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

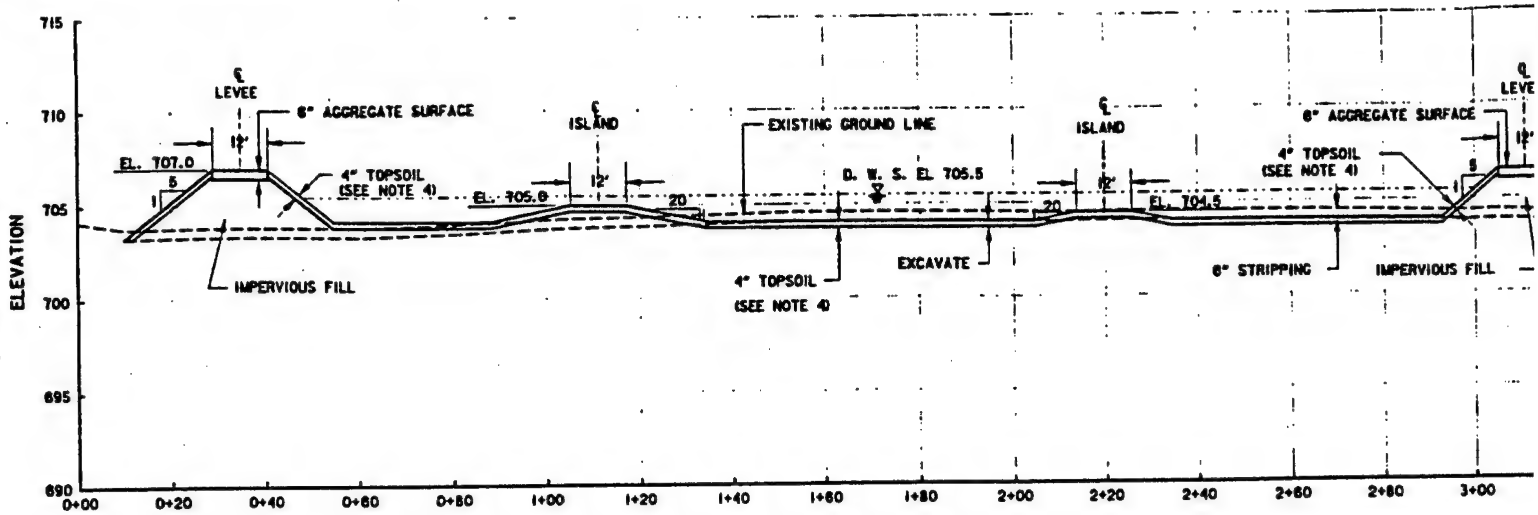
DESIGN MEMORANDUM NO. 2 - SUPPLEMENT NO. 1
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA

MOIST SOIL UNIT AND CHASKA LAKE
CONTROL STRUCTURE GENERAL PLAN

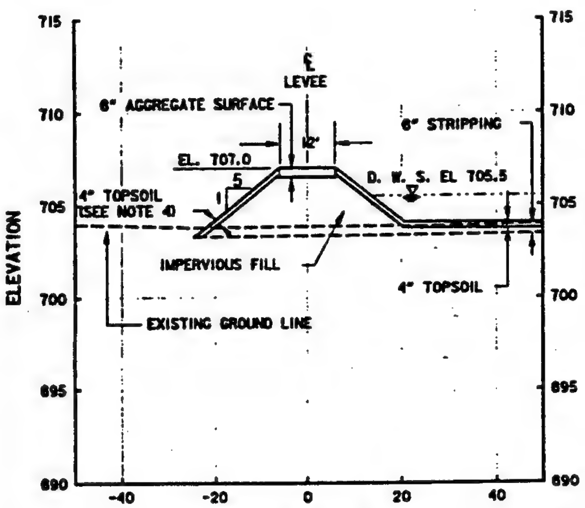
ED-D	DESIGNED:	MMB TLJ
	CHECKED:	
	DRAWN:	MMB
ED-G	DESIGNED:	
	CHECKED:	
DATE: MAR. 10, 1993		

CAD FILE NAME: MSU3D.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/236
SHT 5 OF 7

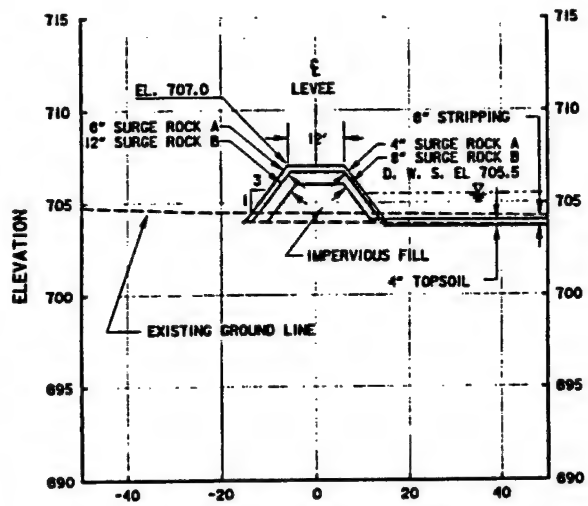
2



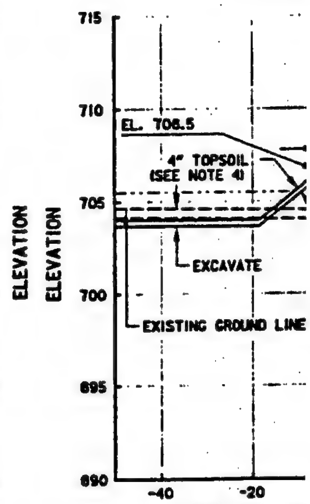
SECTION A 5/236



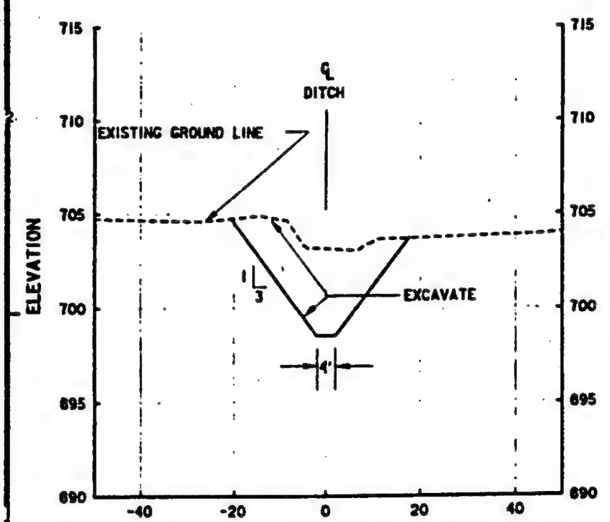
TYPICAL UNPROTECTED
EXTERIOR LEVEE



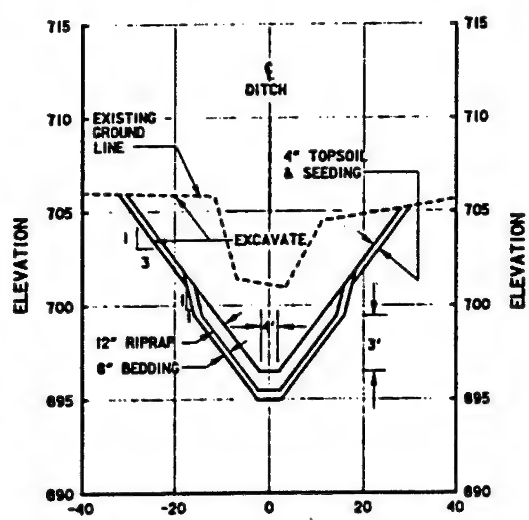
TYPICAL EXTERIOR LEVEE
WITH SURGE ROCK



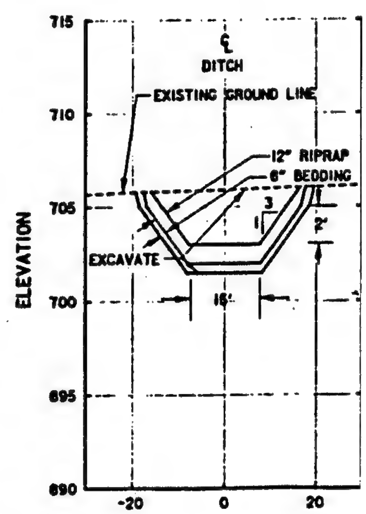
TYPICAL IN



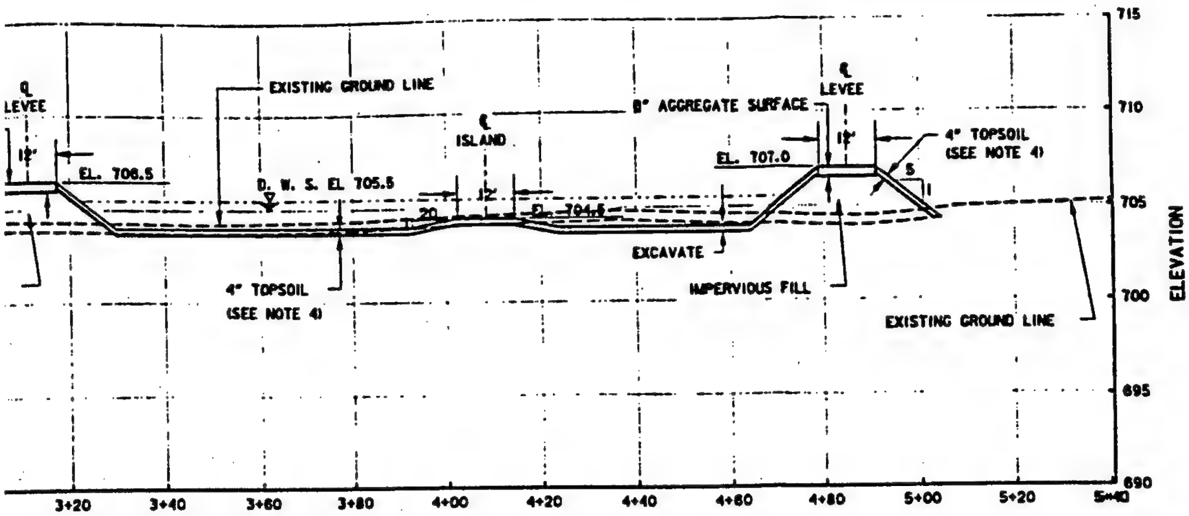
TYPICAL DRAINAGE DITCH
FOR LAKE



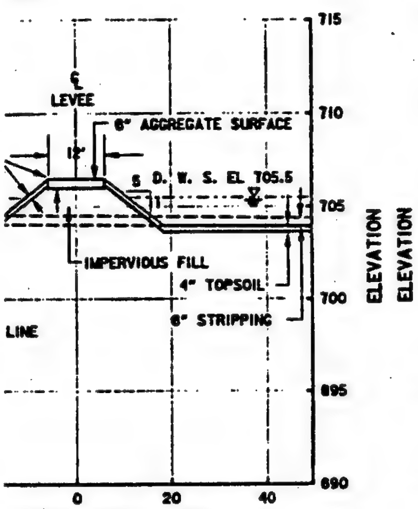
SECTION C 5/236
CHASKA LAKE DITCH
AT PREFORMED SCOUR
HOLE



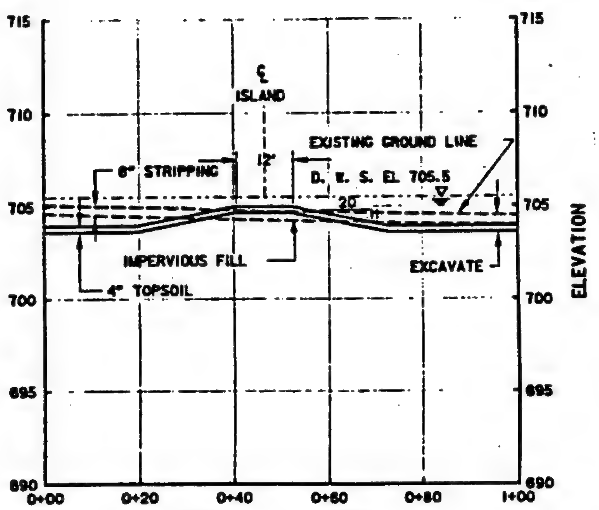
SECTION
MOIST SOIL UNIT
OUTLET DITCH



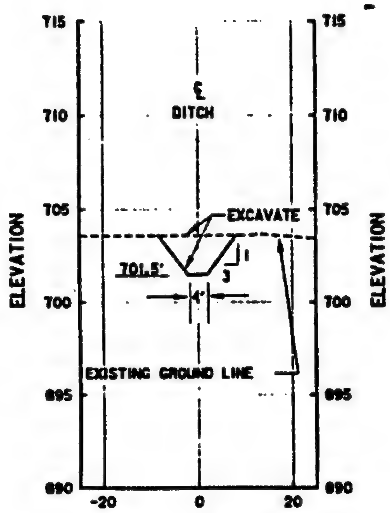
A
/238



INTERIOR LEVEE



TYPICAL ISLAND



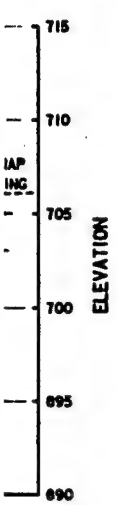
TYPICAL
MOIST SOIL UNIT
INLET DITCH

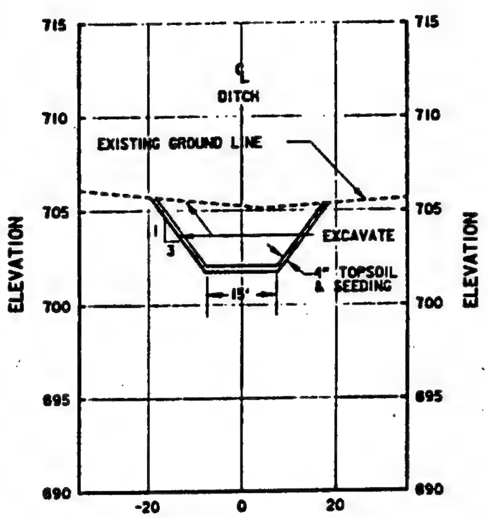
NOTES:

1. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
2. SECTIONS DRAWN LOOKING DOWNSTREAM.
3. D. W. S. MEANS THE DESIGN WATER SURFACE
4. ALL LEVEE SLOPES WITH 4" TOPSOIL SHALL BE SEEDED. ISLANDS AND INTERMEDIATE AREAS SHALL NOT BE SEEDED.

REFERENCES:

	DWG NO.
CONTROL STRUCTURE	5/238





B
5/238

TYPICAL MOIST SOIL UNIT
OUTLET DITCH

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

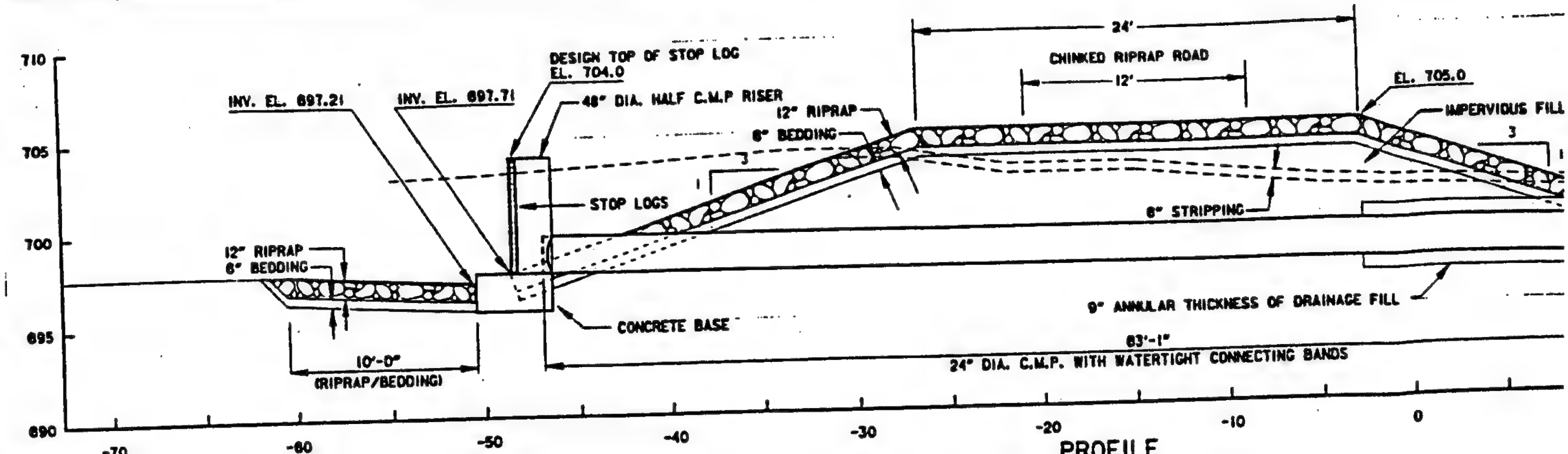
DESIGN MEMORANDUM NO. 2 - SUPPLEMENT NO. 1
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA

MOIST SOIL UNIT AND CHASKA LAKE
DIKE, ISLAND, AND DITCH
CROSS SECTIONS

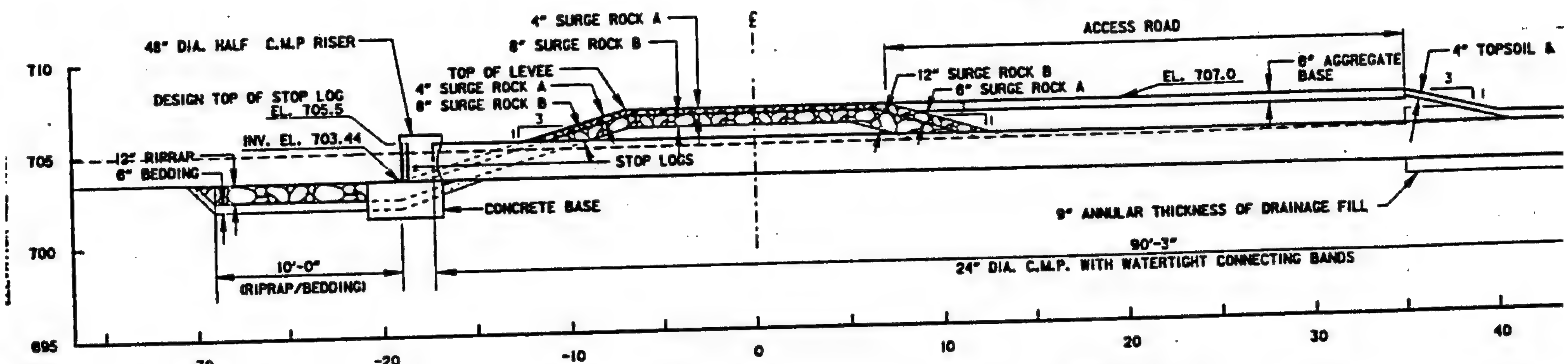
ED-D DESIGNED:	MMB TLJ
CHECKED:	
DRAWN:	MMB TJ
ED-GN DESIGNED:	
CHECKED:	
DATE:	MARCH 11, 1993

CAD FILE NAME: MSUXS3.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/237
SHT 8 OF 9

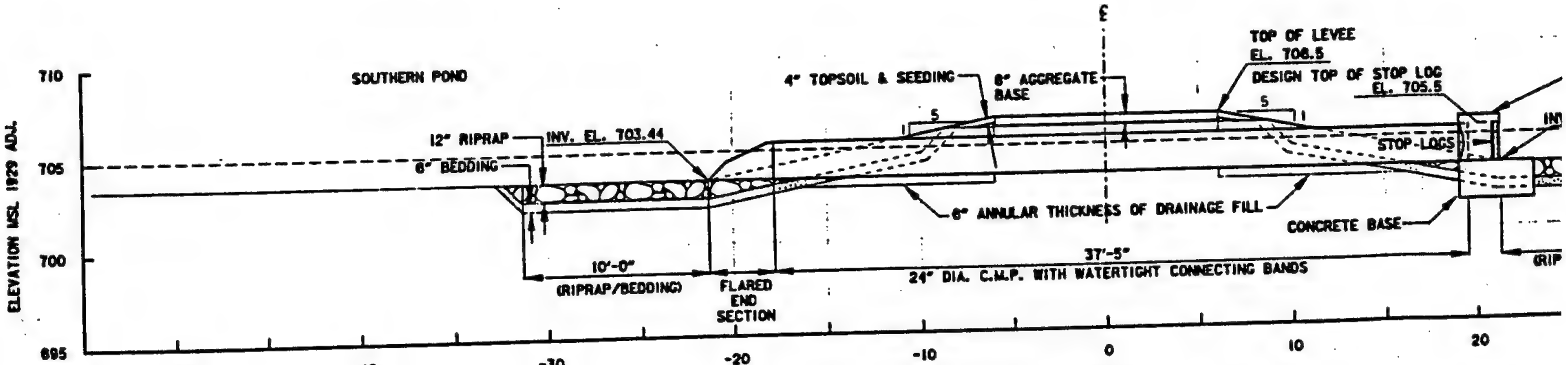
2



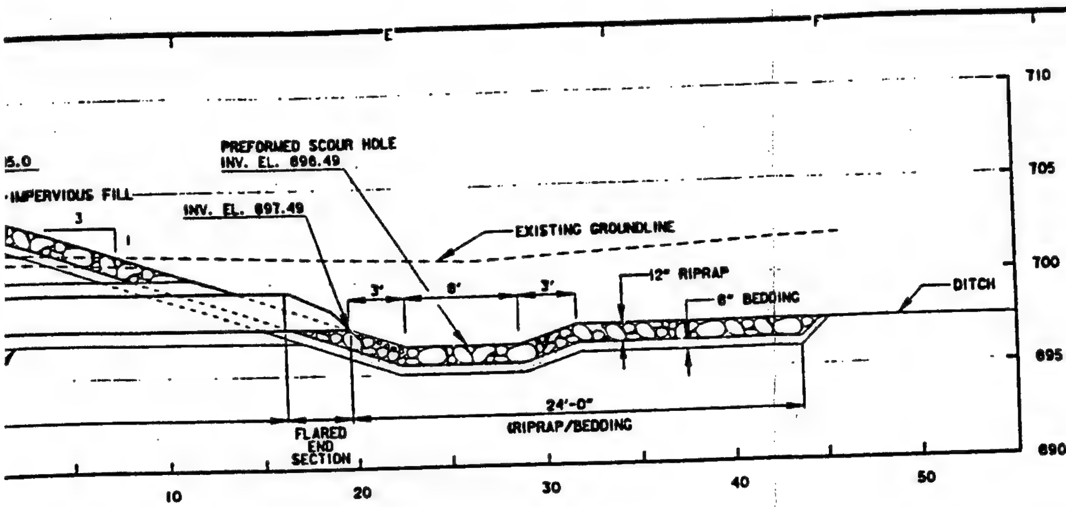
PROFILE
CONTROL STRUCTURE NO. 1
SCALE: 1" = 5'-0"

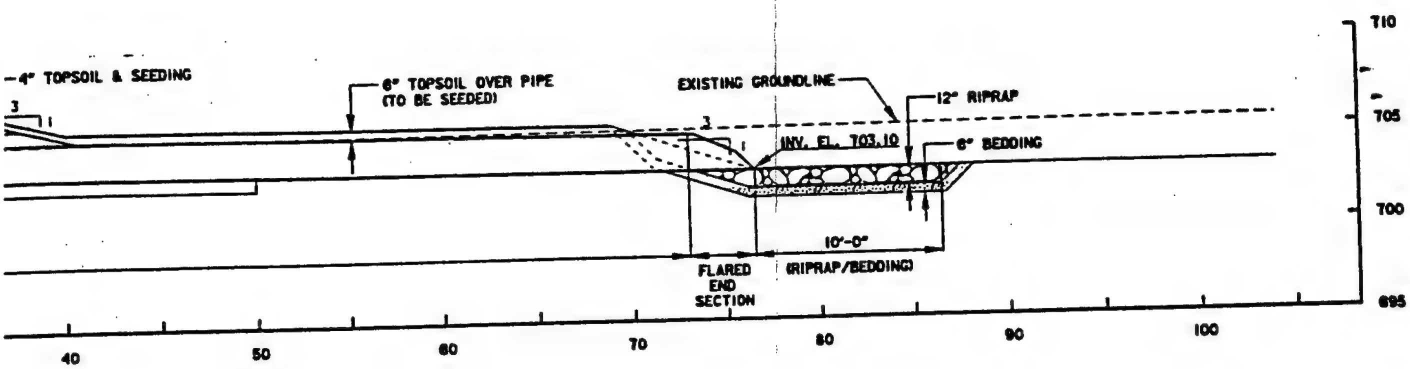


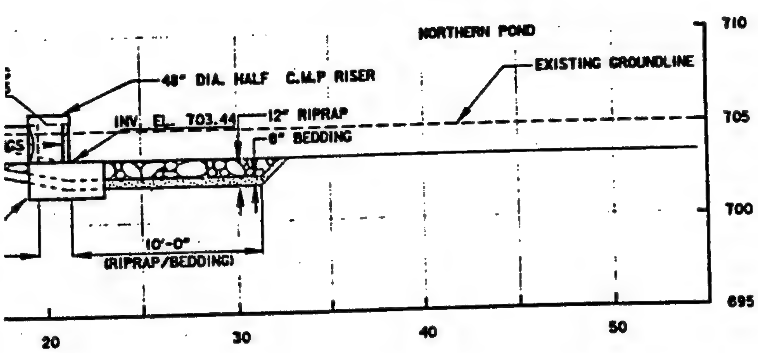
PROFILE
CONTROL STRUCTURE NO. 2
(CONTROL STRUCTURE NO. 3 IS SIMILAR)
SCALE: 1" = 5'-0"



PROFILE
CONTROL STRUCTURE NO. 4
SCALE: 1" = 5'-0"







NOTES:

1. ANNULAR DRAINAGE FILL EXTENDS FROM THE POINT DIRECTLY UNDER THE EDGE OF THE TOP OF LEVEE TO THE LEVEE TOE OR TO ITS INTERSECTION WITH SCOUR PROTECTION

2. ACCESS PLATFORMS TO CONTROL STRUCTURES NOT SHOWN ON THIS DRAWING. SEE DRAWING 5/239.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

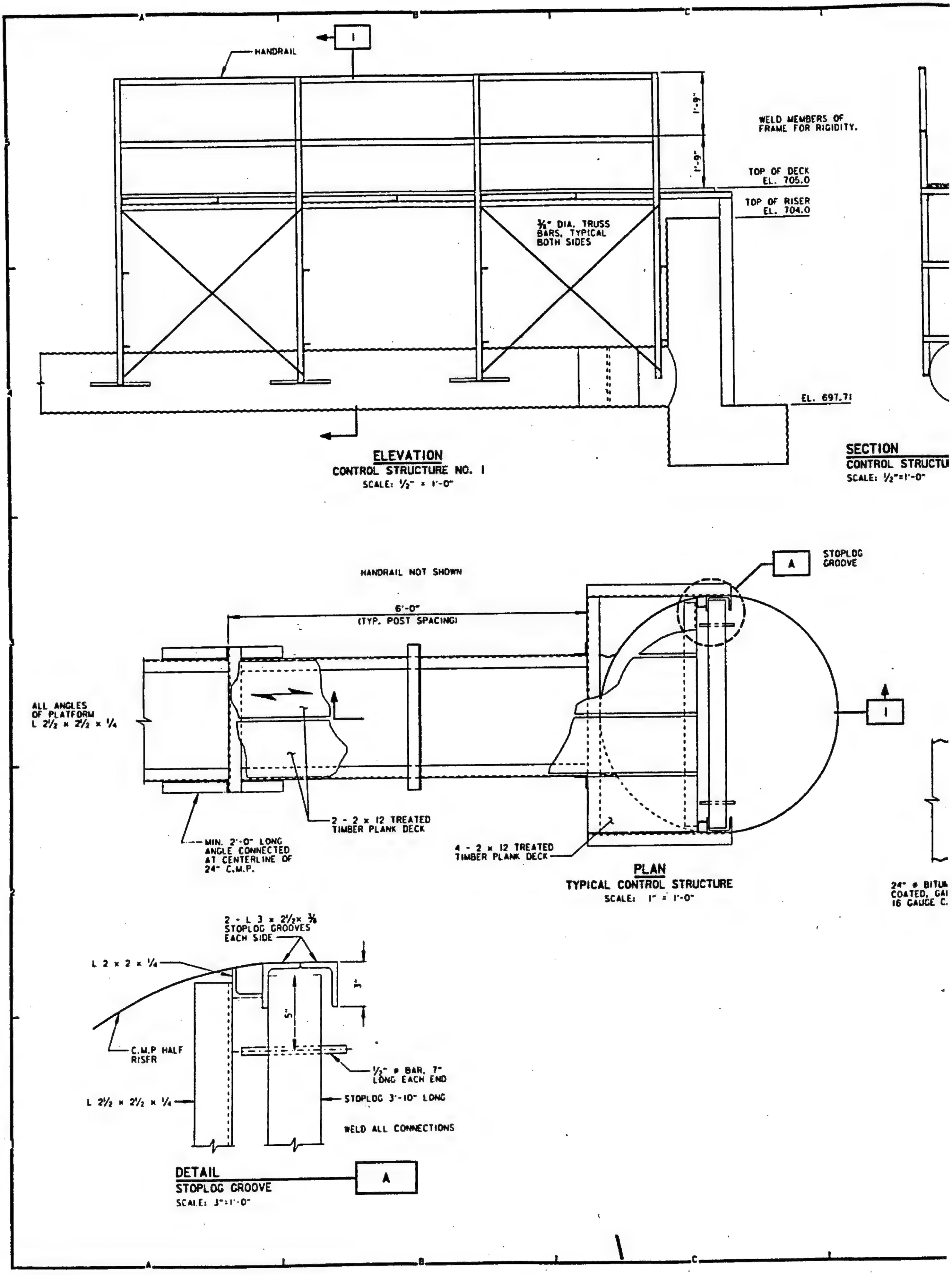
DESIGN MEMORANDUM NO. 2 - SUPPLEMENT NO. 1
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
MOIST SOIL UNIT AND CHASKA LAKE
CONTROL STRUCTURES PROFILES

ED-D	DESIGNED:	MMB TLJ
	CHECKED:	
	DRAWN:	LKT
ED-CM	DESIGNED:	
	CHECKED:	

DATE: MARCH 10, 1993

CAD FILE NAME: NCO4RMSU.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/238
SHT 7 OF 9

2



GEN ENG

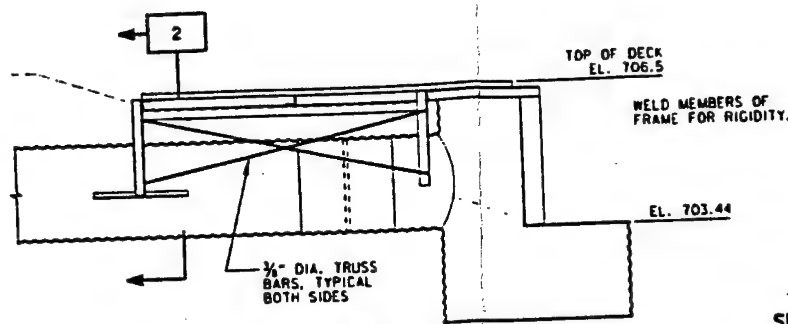
HYD

HYDR

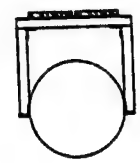
GEOTECH

ENG

MEA



ELEVATION
CONTROL STRUCTURE NOS. 2 & 3
SCALE: 1/2" = 1'-0"



SECTION 2
CONTROL STRUCTURE
NOS. 2, 3 & 4
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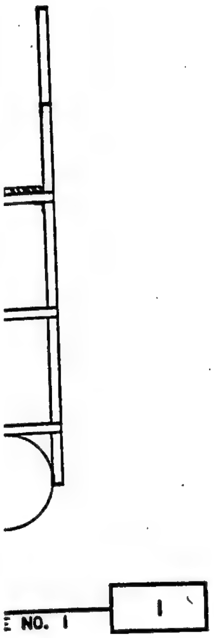
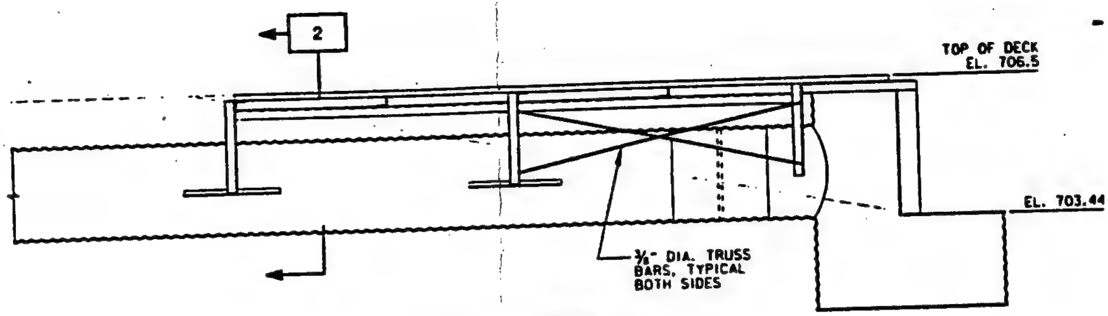
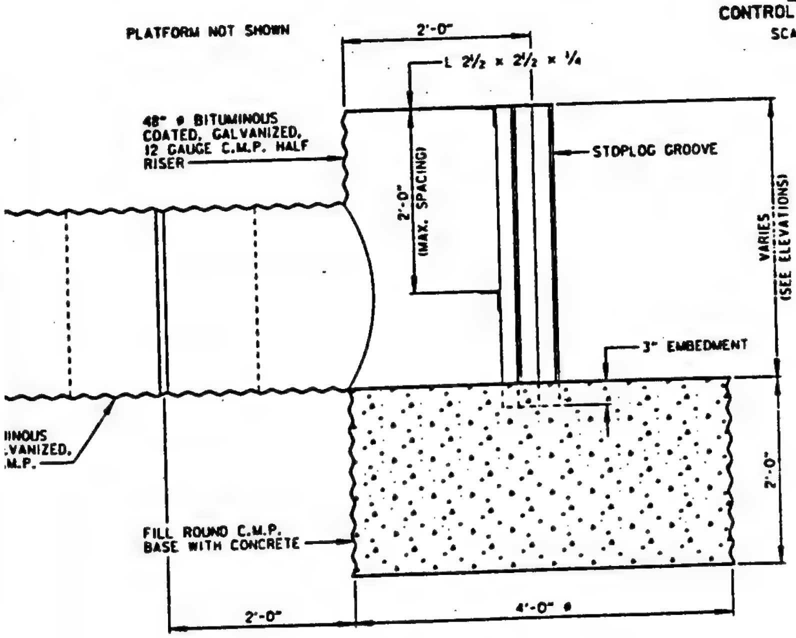
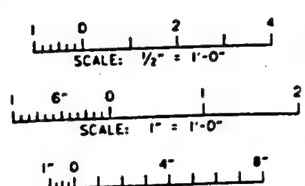




ELEVATION
CONTROL STRUCTURE NO. 4
SCALE: 1/2" = 1'-0"



SECTION 1
TYPICAL CONTROL STRUCTURE
SCALE: 1"=1'-0"



2

SYMBOL	DESCRIPTION	DATE	APPROVAL

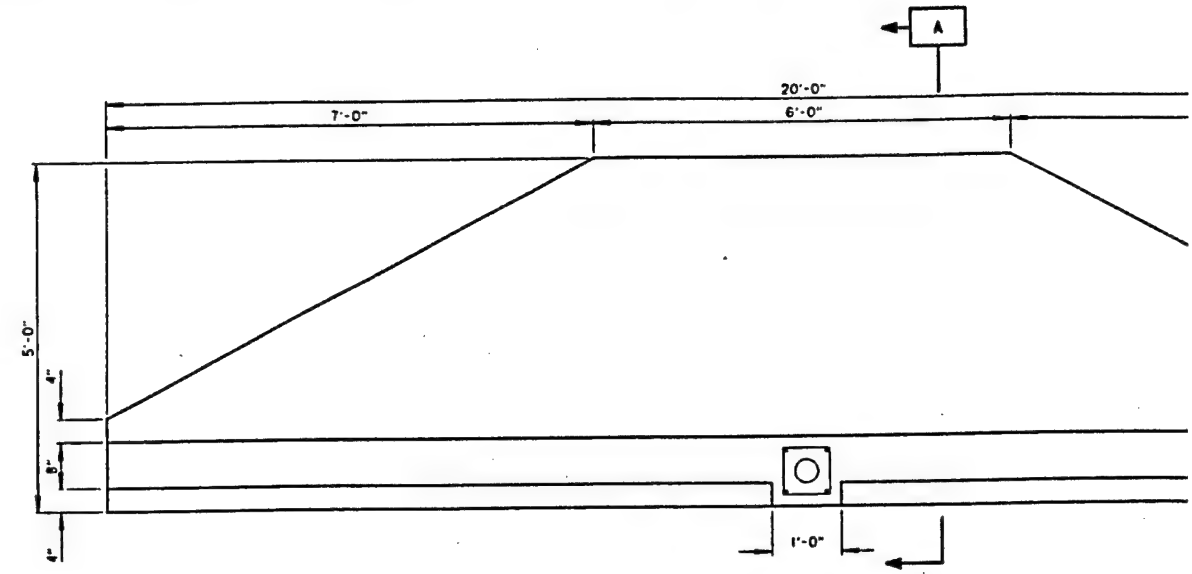
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

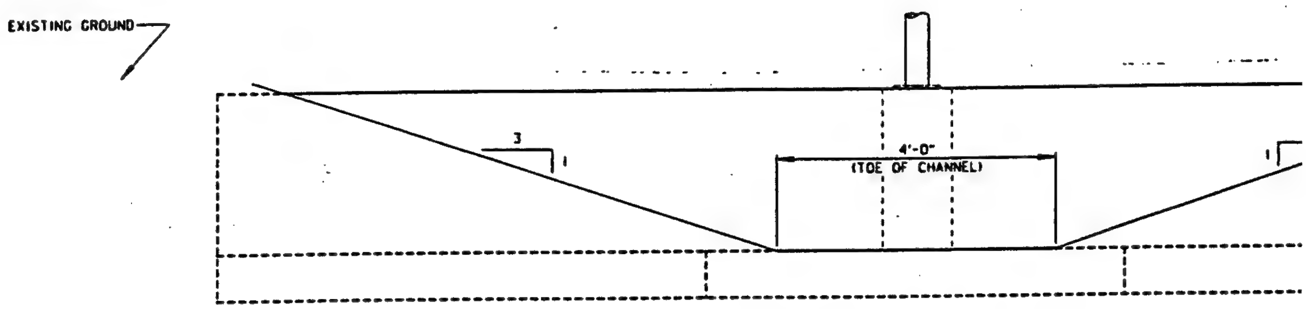
ED-D	DESIGNED:	NRH
	CHECKED:	
	DRAWN:	LKT
ED-GH	DESIGNED:	XXX/XXX
	CHECKED:	
DATE: 03-11-93		

DESIGN MEMORANDUM NO. 2 - SUPPLEMENT NO. 1
MOIST SOIL UNIT & CHASKA LAKE
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT — CHASKA, MINNESOTA
MOIST SOIL UNIT
CONTROL STRUCTURES & PLATFORMS
PLAN, ELEVATIONS, SECTIONS & DETAIL

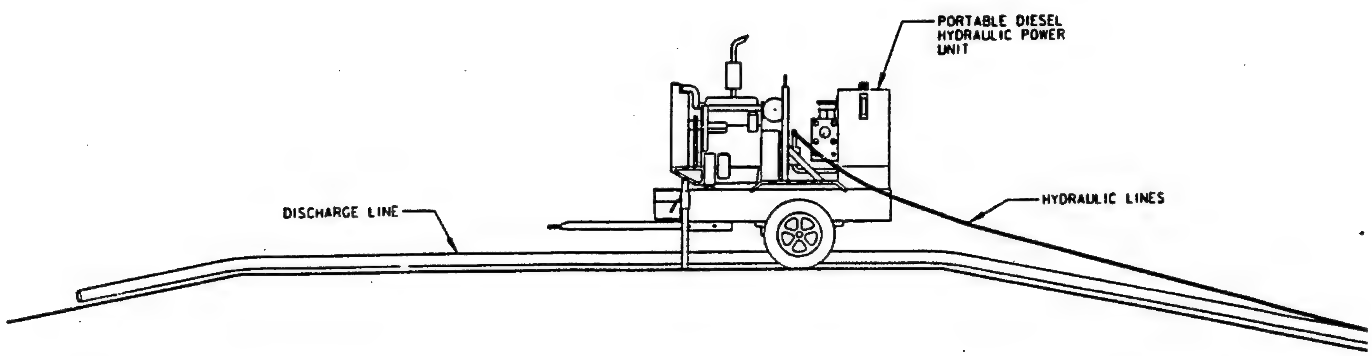
CAD FILE NAME: CHASMSU1.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/239
SHT 8 OF 9



PLAN
CONCRETE WALL AND CRANE BASE
SCALE: 3/4" = 1'-0"



ELEVATION
CONCRETE WALL AND CRANE BASE
SCALE: 3/4" = 1'-0"



CHASKA LAKE PUMPING DIAGRAM

SCALE: NONE

GEN ENG

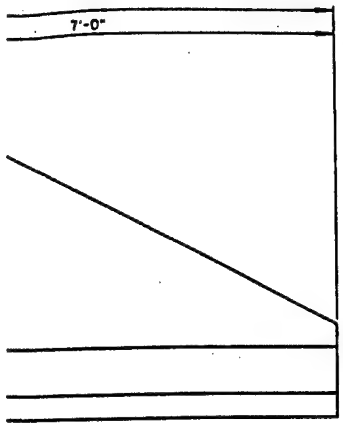
HYD

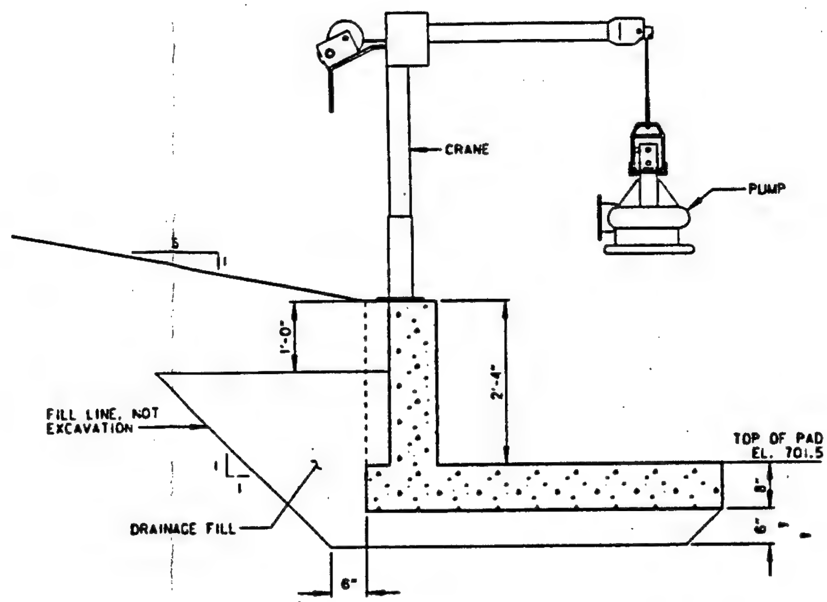
HYDR

GEOTECH

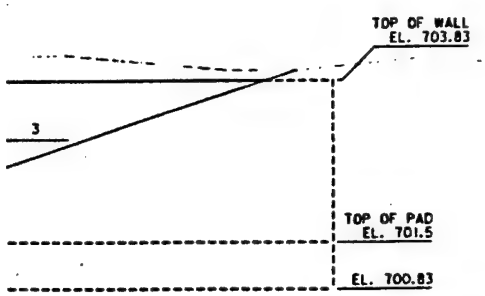
STR ENG

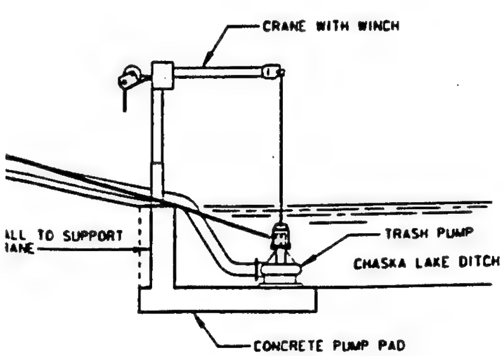
MEA





SECTION A
INLET WALL
SCALE: 3/4"=1'-0"





1 6" 0 1 2
SCALE: 3/4" = 1'-0"

2

SYMBOL	DESCRIPTION	DATE	APPRO

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:	DESIGN MEMORANDUM NO. 2 - SUPPLEMENT NO. 1 MOIST SOIL UNIT AND CHASKA LAKE FLOOD CONTROL - MINNESOTA RIVER CHASKA PROJECT CHASKA, MINNESOT MOIST SOIL UNIT INLET PORTABLE PUMP, CRANE & WALL PLAN, ELEVATION, SECTION & DIAGRAM		
ED-D DESIGNED: NRH			
ED-D CHECKED:			
ED-D DRAWN: LKT			
ED-CM DESIGNED: XXX/XXX			
ED-CM CHECKED:	CAD FILE NAME: CHASMSU2.DGN	DRAWING NUMBER: M34-CH-R-5/240	SHT 9
DATE: 05-13-93	SPEC NO:		OF 9

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

21 OCT 1991

CECW-EP-E

MEMORANDUM FOR Commander North Central Division,
ATTN: CENCD-PD-ED-TM

SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota, Design Memorandum No. 2, Stage 4, Minnesota River

1. Reference CENCD-PE-ED-TM, 2nd endorsement with enclosures, subject as above, dated 12 Aug 91.

2. The DM has been reviewed and the following comments are provided for appropriate action.

a. Page 5, Section 21. Although environmental documentation is completed, it was done prior to current HTW awareness. Suggest that CENCS formally document their evaluation of the HTW potential of this project for any future reference. Such an effort would be in keeping with CECW-PO guidance "Draft Guidance on Hazardous and Toxic Wastes (HTW) for Civil Works Studies and Projects," dated 30 Jul 90. An assessment appropriate for a reconnaissance study should be conducted as a first priority, and included in the response to these comments and bound in front of the DM in accordance with EC 1110-2-268, paragraph C-6.

b. Page 7, Real Estate Requirements.

(1) General. A more complete section for real estate should have been prepared. Currently, real estate information is not very detailed and much of the information is scattered through the various sections, making review difficult. Assuming a Real Estate DM is not scheduled, an effort should be made to pull this information together in a more understandable section within this DM.

(2) Page 7, Paragraph 30.

(a) This paragraph states that "...the City will provide...all real estate interest, to include borrow and disposal areas,... Elsewhere in the report, it states that borrow and disposal will be from/at various commercial sites. If real estate is required for disposal of spoil material, indicate acreage and estimated value of such real estate at an appropriate location in the real estate section. If the commercial sites will be sufficient, indicate the estimated value for LERRD crediting purposes.

(b) An Attorney's Opinion of Compensability for each relocation is required. Clarify in this report if this has been accomplished.

c. Page 12, Table 1. The report shows a total project benefit cost ratio of 0.72 based on the latest approved economic analysis in the February 1984 GDM (October 1983 price levels). Since the project is considered a continuing PED activity, the economic analysis must be updated every two years per EC 11-8-2, para. 8d, and ER 1105-2-100, para. 5-18b. As such, the current total project benefit cost ratio should be revised based on updated benefits. The Remaining Benefits- Remaining Costs Ratio should also be presented since it is required in support of the budget request (EC 11-8-2, para. B-2.13d.)

d. Page 13, Paragraph 43. The cost estimate for O&M is provided here without any detailed breakdown elsewhere in the report. Identification of the major elements, quantities and total cost per item should be included as a minimum. This permits the reviewer to see the same level of information which should have been passed on the local sponsor for their budgetary planning purposes.

e. Mechanical.

(1) Page E-8. In calculating the total head, Paragraph a., page 12, of EM 1110-2-3105 should be followed. Arrangement c of Sketch No. 1 on page 13 of the EM is similar to the type used in this DM. Static Head calculated in accordance with that sketch should be (725.9 - 698) = 27.9 feet instead of the 31 feet shown.

(2) Care should be given in the design of the approach and forebay for the pumping station due to the fact that the storm water has a 90^{o} turn before entering the forebay area. ETL 1110-2-313 should be used as guidance for the design.

(3) Design analysis covering pump design/selection and pump station configuration should be included for review.

f. Electrical.

(1) A one line diagram of the electrical distribution system should be provided as a part of this DM. A schematic diagram of the reduced voltage starting system for the submersible pump motors should also be provided.

(2) Appendix E, Paragraph 30. This paragraph specifies that the submersible pump motors shall be capable of operating continuously in a totally, partially, or non-submerged conditions. These motors are not normally designed to operate in a non-submerged condition; therefore it is questionable whether motors can be procured that will meet this requirement. Even the operation of these motors in a partially submerged condition is questionable and should be avoided. To operate the motor in a partially or non-submerged condition would require that the float switches be by-passed. The motor would then be shut-down by the temperature sensors specified in paragraph 32(13). This requirement should be verified and its use should be fully justified.

(3) Load demand and short circuit calculations have been provided; however, it does not appear that voltage drop calculations have been made. These calculation should be added to the electrical calculations.

g. Cost estimates are reported differently in this DM and in various other documents being processed concurrently. For example, the total cost of Stage 4 is shown as $11,817,000 on page G-3 of the DM; as $10,981,000 in the most recent PES, Part IV; and as $10,955,000 in the just processed SACCR. In addition, the Total Project Cost is shown as $38,700,000 in the Executive Summary of DM #2, and in the PES as $35,500,000 for the Current Approved Estimate and as $41,200,000 for the Forecast Estimate. Steps should be taken to assure consistency among these various documents.

3. Respond as to action taken on these comments within 60 days. The Engineering Division POC is Mike Smith, CECW-EP-E, (202) 272-8951.

FOR THE DIRECTOR OF CIVIL WORKS:

Encl wd

JOHN A. McPHERSON
Acting Chief, Engineering Division
Directorate of Civil Works

CENCD-PE-ED-TM (CECW-EP-E/21 Oct 91) (1110-2-1150a) 1st End
Mr. Ordonez/(312)-353-9057
SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota, Design Memorandum No. 2, Stage 4, Minnesota River

Commander, North Central Division, U.S. Army Corps of Engineers, 111 N. Canal Street, Chicago, IL 60606-7205 07 NOV 1991

FOR Commander, St. Paul District, ATTN: CENCS-ED-M

1. Review comments from CECW-EP-E are forwarded for your action. Responses to comments should be provided to CENCD-PE-ED-TM NLT 15 Dec 91.

2. The HQ, NCD, POC is Mr. Jose Ordonez, (312) 353-9057.

FOR THE COMMANDER:

for JOHN P. D'ANIELLO, P.E.
Director, Engineering and
Planning Directorate

Encl
nc

Rec'd 13 Nov 91
JDH

CENCS-ED-M (1110) (CECW-EP-E/21 Oct 91) 2nd End
Mr. Heyerman/kk/(612) 220-0432
SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota Design Memorandum No. 2, Stage 4, Minnesota River

FOR Commander, North Central Division, ATTN: CENCD-PE-ED-TM, River Center Building, 111 North Canal Street, Chicago, Illinois 60606-7205

Commander, St. Paul District, ATTN: CENCS-ED-M, 180 Kellogg Blvd. E., Room 1421. St. Paul, Minnesota 55101-1479 12 DEC 1991

1. Responses to comments contained in the 1st Endorsement follow with reference to comment number.

2. Comment 2.a. Potential contaminated sites have not been identified in this stage through geotechnical investigations or through discussions with the City of Chaska. An environmental site history assessment has been conducted. The available evidence shows that the portion of Chaska along the levee has never been developed for other than residential use. No businesses, either retail or manufacturing, were located along the levee (within at least one city block) since Chaska was settled in the 1850's. Therefore, it is highly unlikely that any hazardous/toxic sites exist within Stage 4 of the Chaska Flood Control project.

3. Comment 2.b. (1). The level of detail for real estate requirements for this stage of work is appropriate. The District has worked closely with the City of Chaska on acquisitions for the completed Chaska Creek diversion. Real estate drawings for this stage of work were provided to the City of Chaska on 23 August 1991, and the city is actively acquiring necessary real estate interests.

4. Comment 2.b. (2)(a). Real estate interest is not required in the commercial disposal area proposed for this project (page F-3). The major commercial site for impervious fill will be leased by the City of Chaska. The estimated value for LERRD crediting is $176,000 (page G-7).

5. Comment 2.b. (2)(b) - It is CENCS-RE opinion that utility relocations listed in Table F-1 and road relocations listed on page 4, paragraph 15, are compensable and part of the Chaska Flood Control project. A formal Attorney's Opinion of Compensibility for the relocations has not been accomplished to date. An Attorney's Opinion will be completed prior to contract advertising.

6. Comment 2.c. This project is currently under construction and is no longer classified as PED. Guidance pertaining to PED should not be imposed at this stage. Since there is an existing LCA committing the COE to this project and since significant expenditures have already been made, the overall project BCR is no longer the major issue. The pertinent cost ratio is the Remaining Benefits-Remaining Costs Ratio, which is 1.3 to 1 at 8 7/8 percent for this project. It should be noted that completed work is not producing its overall intended function of removing the City of Chaska from the threat of flooding

and the remaining work is critical to the overall functioning of the project. Therefore, the remaining benefits are the total project benefits and the remaining costs are those related to the remaining work. The 9 July 1991 CECW-P memorandum, Subject: Reporting and Updating Benefit Cost Ratios for Civil Works projects, defines a separable element as having "operational, environmental and economic impacts directly related to, and only associated with the individual project element...Independent hydrologic effects connote a hydrologic and hydraulic independence from the output and benefits of other projects..." It is the Districts opinion that the Chaska Creek diversion does not meet the guidelines as a separable element. Also, no separable elements are identified in the project LCA, which was executed on 12 September 1988.

7. Comment 2.d. The O&M cost estimate for this stage of work is $30,364 per year and consists of the following major components:

Riprap/Bedding	$3,882
Pump Station	$2,750
Pavements	$7,096
Levee Maintenance	$6,335
Inspections	$10,000
Other	$301

8. Comment 2.e. (1). Static head should be 27.9 feet as indicated in the comment. Total dynamic head would then be 33.5 feet. Operating condition for the pump would be 6,000 gallons per minute at 33.5 feet of total dynamic head.

9. Comment 2.e. (2). Station has been designed to account for the 90 degree turn the water will make.

10. Comment 2.e. (3). Pump design and selection criteria have been provided in Appendix E. Any further information needed beyond that shown should be requested. Station layout analysis is indicated on the attached enclosure 1. Design has followed Hydraulic Institute Standards.

11. Comment 2.f. (1). See the attached enclosure 2.

12. Comment 2.f. (2). The submersible pumps selected are designed to either operate at the centerline of the volute or at the top of volute. Station has been designed so the minimum water level when pumping will be elevation 698.0. This elevation will be above the pump volute and is approximately in the center of the motor. Pump will not overheat under these conditions.

13. Comment 2.f. (3). See the attached enclosure 3.

CENCS-ED-M
SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota Design Memorandum No. 2, Stage 4, Minnesota River

14. Comment 2.g. Cost estimates vary based on timing of reporting requirements, whether E&D and S&A is included, whether the estimate is inflated through construction or indexed to a certain year price level. Consistency is difficult due to the number of various documents and timing of those documents. The PES estimate specifically states it is October 1991 price level and the DM estimate specifically states it is an inflated, fully funded estimate.

FOR THE COMMANDER:

3 Encls
1. Sump dimensions
2. One line, etc.
3. Electrical calcs.

for Steve Kumpula
ROBERT F. POST
Chief, Engineering Division

CENCS-ED-M (1110) (ED-M/24 Apr 91) 2nd End
Mr. Heyerman/kk/(612) 220-0432
SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota Design Memorandum No. 2, Stage 4, Minnesota River

FOR Commander, North Central Division, U.S. Army Corps of Engineers, ATTN: CENCD-PE-ED-TM, 111 N. Canal Street, Chicago, Illinois 60606-7206

Commander, U.S. Army Corps of Engineers, 180 Kellogg Blvd. E., Room 1421, St. Paul, Minnesota 55101-1479 29 JUL 1991

1. Responses to comments contained in the 1st Endorsement follow with reference to commentor name and number.

2. Korbus 1.

a. Paragraph 15 on page D-3 of the Structural Appendix describes the uplift conditions as given to the Structural Section from the Geotech Section. At the pumping station wall 28' from the berm toe, the uplift head increases to El. 716 from El. 713 at the berm toe. Attachment 1 shows these uplift head elevations through the levee at the pumping station.

b. The uplift head for the pump station was determined in the following manner. The maximum head at the midpoint distance between two adjacent wells was used as the maximum expected landside head. A straight line interpolation between the seepage entrance and the berm toe was then used to determine the uplift pressures at the pump station. A summary of uplift calculations is given in Table 2 of appendix C.

3. Korbus 2. According to appendix B of ER 1110-2-1150 "Engineering After Feasibility Studies", a Design Memorandum does not require structural design computations to develop details for this type structure. Including the area of steel required and identifying reinforcing selected is more detail than necessary for the Design Memorandum. For the convenience of your review, the maximum area of steel required and reinforcing size for the pump station wall design of this DM will be given using the formula on the last line of page D-8. Add the following information at the end of each page of the calculations listed.

<u>Page</u>

D-8:As(Mu=560"k,d=14.5")=.75 sq in/ft max. reinf. req'd.- #8@12"

D-10:As(Mu=670"k,d=20.5")=.62 sq in/ft max. reinf. req'd.- #5@6"

D-13:As(Mu=397"k,d=20.5")=.37 sq in/ft max. reinf. req'd.- #6@12"

D-14:As(Mu=158"k,d=10.5")=.29 sq in/ft max. reinf. req'd.- #5#12

D-16:As(Mu=783"k,d=12.5")=1.26 sq in/18" wide beam max. reinf. req'd. 3-#6

4. Korbus 3. A revised page D-18 is attached. The different areas of the pump station are labeled along with wall and slab thicknesses. The descriptions of the structural features in the calculations can be identified more plainly on the revised sketch. This should help in your review.

5. Korbus 4. Paragraph 4-7.b of EM 1110-2-3104 refers to the Mechanical EM 1110-2-3105 for discussion of forces on the gate structure induced by gate operation. EM 1110-2-3105 says the components of the sluice gate lifting device (like the stem) shall fail under extreme load before the support. The standard method of sizing sluice gate components in this District is to use a safety factor of 5. This is the way the sluice gate specification is written. Since the components of the gate are designed for this safety factor, the support shall be designed for that safety factor also.

6. Korbus 5. The uplift head for the pump station was determined in the following manner. The maximum head at the midpoint distance between two adjacent wells was used as the maximum expected landside head. A straight line interpolation between the seepage entrance and the berm toe was then used to determine the uplift pressures at the pump station. A summary of uplift calculations is given in Table 2 of appendix C.

7. Korbus 6. A mistake was made in the table on page D-41 of the Structural Appendix for the 72" pipe. The Table should say H = 9.92 ft., We = 10,360 #/ft. and D-load = 1150 #/l.f./ft. diam. Class III-72" diameter pipe will be adequate for this D-load.

8. Tenke-White 1. Concur. On page G-5, the item Mob & Demob was changed to 16,550 and on page G-6 the manhole subtotal was added. Also a dashed line was added throughout the estimate between the item subtotal and the item's subitems. This resulted in more pages which required a revised Table of Contents and revised pages G-5 through G-24.

9. Tenke-White 2. Concur; Revised page G-8 provided.

10. Tenke-White 3.

a. Concur.

b. The District's Construction Management costs on large projects such as Chaska Stage 2, which is currently under construction, has been running at about 6.1 percent. The 6.5 percent indicated is adequate.

11. Tenke-White 4. Recent analysis by our Cost Engineering Branch indicate engineering costs for projects between $1,000,000 and $10,000,000 range from 35 to 15 percent. Interpolation results in 24.4 percent for Chaska Stage 4. Items that tend to increase the Stage 4 rate are:

CENCS-ED-M (1110)
SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota Design Memorandum No. 2, Stage 4, Minnesota River

a. The relatively small pump station requires about the same design effort as a large more expensive pump station.

b. Good design reduces construction cost which in turn increases the engineering rate.

c. Stage 4 is a complex project.

12. Tenke-White 5. A phone conversation with the commentor determined that the 30 account should be the 31 account in the original comment. The District's Construction Management costs on large projects such as Chaska Stage 2, which is currently under construction, has been running at about 6.1 percent. The 6.5 percent indicated is adequate.

13. Tenke-White 6. No response required.

14. Vento 1. As indicated in paragraphs 19 (page B-6) and 24 (page B-7) and shown on Plate 6 of the General Design Memorandum revised in August 1984, the former pumping station location was near Pine Street, adjacent to outlet B.

15. Vento 2. TP 40 and TP 49 are required to obtain rainfall amounts for durations longer than 24 hours. Theoretical rainfall amounts for durations of 24 hours or less for new start projects are obtained using HYDRO-35.

16. Vento 3. Concur. Plate A-12 was not used and should be eliminated from the report. The rainfall amounts presented in table A-1 are the same as presented in table B-1, page B-18 of the General Design Memorandum, revised August 1984. The rainfall-duration curves presented on Plate A-13 are the same curves as presented on Plate B-16 of same reference.

17. Vento 4. Page ii which includes the table of contents for appendix B tables and plates is provided.

18. Vento 5. The estimated peak runoff rate from a SPF at Chaska is about 168,000 cfs. The value of 165,000 indicated in Table 1, page B-3 should be changed to 168,000.

19. Vento 6. The two existing pump stations were constructed about 1951 and are located within the area required for levee and/or berm construction. The pump stations would require extensive and expensive remodeling to meet proposed needs. The existing pumps and motors are old and do not have the required pumping capability or horsepower. The stations are to be demolished and the pumps and motors will be salvaged by the city or construction contractor. Also based on the District's experience, the rehabing of pumps costs about the same as the purchase of a new pump and rehabing does not provide nearly the same useful life.

20. Vento 7. As indicated on pages G-9 through G-11, the cost of the proposed interceptor pipe is estimated to be about $583,000 with contingency, and each outlet about $285,000 with contingency. Therefore, considering that the cost of each outlet structure is about equal to one-half of the cost of the entire length of interceptor pipe, it will not be practical nor economical to increase the number of gravity outlets. Use of the existing outlets in the proposed plan is not practical; because the condition and strength of the existing pipes is unknown, they are extremely small with a relatively high invert elevation, and would require the construction of energy dissipaters at the downstream end.

21. Vento 8. The following is the required size, length, and cost of interceptor pipe based on the recommended plan and on an earlier 1 percent plan investigated:

Pipe Size:	18	24	30	36	42	48	54	60	66	72
Required Length In Ft										
Recommended Plan	190	250	404	404	482	554	394	392	334	336
1 percent Plan	-	590	220	520	940	840	-	550		

The estimated cost of interceptor pipe for the recommended plan is about $583,000 with contingency. The estimated cost of interceptor pipe for the 1 percent plan investigated appears to be about $100,000 less than for the recommended plan. The estimated maximum interior pond level during a SPS event with the recommended plan is designed to match existing conditions and will be about 710.9 in section 2 and about 712.5 in section 3. The estimated maximum interior pond level during a SPS event with a 1 percent plan, based on a combination of inlet and/or pipe control, will be about 711.7 in section 2 and about 715.3 in section 3. Based on the elevation-damage curves presented on Plate A-7, the resulting damages would be about $420,000 for existing conditions and the recommended plan and about $1,040,000 with the 1 percent plan. With the recommended plan the area inundated by a SPS event would cover about 6.2 acres in section 2 and about 7.8 acres in section 3, or a total of about 14 acres, generally located along the proposed line of protection and generally within the project right-of-way. With a 1 percent plan, the area inundated by a SPS event would cover about 9.3 acres in section 2 and about 16 acres in section 3, or a total of about 25.3 acres. The additional 11.3 acres required with a 1 percent plan would extend into residential areas and result in about $620,000 of additional flood damage. It is felt that the approximate $100,000 in additional cost is justified to prevent the inundation of about 11.3 acres of residential property and the possible $620,000 in additional damages. Also, the additional 11.3 acres would likely require flooding easements.

22. Simpson 1. Concur. This will be required by the specification.

22. Simpson 2. Do not concur. The determination of embankment saturation should consider the melting of snow and/or ice, rainfall, pervious seams in the existing embankment and pervious seams in the foundation soils as well as the flood duration. Also, at Chaska, the flood duration can be extended several days by backup from Mississippi River flooding. Considering the minimal time required to analyze the two cases and the fact that the embankment slopes required by either maintenance considerations or other stability cases will usually provide adequate factors of safety for the two cases in question, it is generally much quicker (and therefore more cost-effective) to simply assume embankment saturation, analyze the two cases and show that required factors of safety are met rather than attempt to evaluate all factors that may contribute to embankment saturation and then argue the applicability of the cases and/or the validity of the evaluation.

23. Simpson 3. Do not concur. The soil strength after consolidation has already been selected somewhere between the Q-strength and R-strength. The soil layers 5 & 6 are consolidated from the first stage fill and will probably be 90 percent to 100 percent consolidated before additional loads are applied. The strengths for these layers were obtained from the R-strength test information using the normal stress from the first stage fill and so they essentially have a phi value in them.

24. Simpson 4. Concur. The strength and stress/strain characteristics of the embankment soils are not known at this time but will be determined for preparation of the plans and specifications. At that time stability analyses will be redone with appropriate stress/strain considerations and with the higher foundation strengths mentioned in paragraph 22 on page C-6.

25. Simpson 5. Concur. The results are correct. The attached Table A shows the Q-strength data for the soft foundation layer. The data does not show any definitive trend of increasing strength with increasing depth. Agree that the "average" foundation soil strength is likely 400 psf.; however, design strength was selected at the one-third point in accordance with EM 1110-2-1902.

26. Simpson 6. Do not concur. The crack depth was determined from the formula on page 24 of the "USER'S GUIDE: UTEXAS2 SLOPE-STABILITY PACKAGE, Volume II: Theory". The crack depth used in the analysis is about one-half that calculated from the formula on page 43 of the Contract Report. Note that if phi=0, the crack depth formula from the USER'S GUIDE is 2*c/(gamma*F) or one-half the 4*c/(gamma*F) formula given on page 43 of the Contract Report. The USER'S GUIDE formula is considered the correct formula for determining the depth of tension cracks. If crack depths of 7.5 to 10 feet were obtained using the 4*c/(gamma*F) formula, it appears the 300 to 400 psf strength of the soft foundation soil must have been mistakenly used in the calculation instead of the 1200 psf strength of the embankment. Although a shallower-depth crack and a higher foundation strength would obviously result in a higher factor of safety, they are not considered appropriate for the analysis.

27. Simpson 7. Concur in part, Do not concur in part. NCS computations are not for a "deeper than usual crack analysis"-see response to comment 6. Note that the end of construction factor of safety of 1.0+ given in the report is for the end of the first stage of construction. At that time a factor of safety of 1.3 is not required since the new levee has not yet replaced the existing emergency levee as the main line of protection. As shown in the report, the end of construction factor of safety exceeds the required 1.3 at the end of the second (final) stage of levee construction when the new levee could become the main line of protection, if necessary, by filling the East Creek opening and pumping East Creek flow over the new levee. Strength increase from consolidation is needed for both second stage levee construction and to increase factors of safety to required values when second stage construction is complete. A discussion of the time rate of consolidation, with at least a sample computation, should have been included in the report but was unfortunately overlooked during final report preparation. The attached Table B provides a summary of time/settlement data for first stage loading at a typical levee section. Ultimate settlements are shown in the first row for 20 foot increments across the section. Remaining rows show the amount of settlement at the end of the number of years shown in the left-most column. At the levee centerline (x=0) the data show 60 percent of the ultimate settlement will occur in about 5 years and that about 20 years would be required to reach 95 percent consolidation. Consequently, consolidation will not occur in a short time period unless drainage of the compressible layer is significantly enhanced.

28. Simpson 8. Concur. Note that the existing embankment on the east side of Courthouse Lake has a top elevation of 716+ which is about ten feet lower than the new levee. Also the existing embankment was constructed on the edge of an old clay mine pit (Courthouse Lake) where the foundation soils may not have been as poor as those encountered where the new levee is being constructed. The existing levee was also raised as less frequent floods occurred, resulting in an actual (though unplanned) staged construction.

29. Simpson 9. Concur. Because of time constraints only the worst case condition was looked at for this reach. Further analyses will be done for plans and specifications to determine if the extent of the wick drains can be reduced or if there are locations where increased spacing is possible and economically practical. However, decreasing the thickness of the clays to 20 feet does not by itself assure rapid consolidation. See the response to comment 7 in regard to the time rate of settlement.

30. Simpson 10. Do not concur. Using UTEXAS2 in accordance with it's User's Guide will probably not give an increased factor of safety with increased levee material strength. Also, the strength of the levee fill has not been determined and may be lower than what is used in the report. When the strength of the borrow material is obtained additional analyses of slope stability will be performed to verify final levee design.

31. Simpson 11. Do not concur. The current design complies with COE slope stability criteria at the completion of levee construction. It would not be desirable for the construction contract to be complete and not have the levee comply with COE slope stability criteria. Note that the end of construction factor of safety for the first stage is just slightly over 1.0. However, at the completion of the second stage (when the levee could easily become the main line of protection) the end of construction factor of safety is 1.3 in accordance with criteria.

32. Simpson 12. Do not concur. A controlled sequence of placement, a layer of granular material between the subgrade and new levee fill, stability berms, and a two-stage construction process are used in the current design. Without the wick drains consolidation will not occur in a reasonable period of time. The effect of levee material strength will be reevaluated when testing of the material is completed. All other alternatives mentioned, except for the reduced cracking depth, have previously been considered. See the response to comment 6 regarding crack depth computations.

33. Simpson 13. Concur. CSETT input is given in attached Table C. A summary of time/settlement computations for first stage construction is given in attached Table B and discussed in the response to comment 7.

34. Simpson 14. Do not concur. Except for the minimum berm width, berm design in the report is in accordance with EM 1110-2-1913. The suggested alternative (a) design procedure is not included in the EM as an OCE-approved berm design and the alternative would provide a less costly berm only because it provides a lower margin of safety. Where relief wells are used the additional real estate costs and reduced benefits which would be required if the berms were used still appear to leave relief wells as the least costly alternative for controlling uplift pressures. The suggested alternative (b) (pervious toe trench and horizontal drain) as shown on Figure 5-4 of EM 1110-2-1913 is not considered a practical, low cost alternative at Chaska because of the large quantity of seepage through the deep pervious zone along the river and because, in some areas, removal of much of the existing levee would be required to construct the pervious trench and horizontal drain. The current design minimizes excavation and replacement of the existing levee in order to minimize cost. Suggested alternative (c) was not considered because of the large trench depth that would be required and the high probability that such a trench would significantly interfere with normal groundwater discharges to the river during non-flood periods.

35. Simpson 15. Concur. In general, construction of all structures for the project results in a net unloading of the soil directly underneath the structure. Because of this net unloading, bearing capacity calculations have not been made. The two structures where settlement may be a problem will need to have analyses completed during plans and specification. The pipes of the

gravity outlet placed upstream of Highway 41 will be checked to determine if banded joints will be required because of the additional fill being placed landward of the levee centerline. The existing pipe exiting on the south side of the sewage treatment plant will need to be renanalyzed because of the additional fill being placed in that location.

36. Simpson 16. Concur in part, Do not concur in part. Discounting the borings taken through existing fill because of consolidation which would have taken place, there are 11 borings of which 5 borings show soft materials to approximately elevation 675. Four additional borings show soft material to approximately elevation 685 and the remaining two borings show soft material to between elevations 690 and 695. The soil profile used for design assumed soft material down to elevation 675 at some distance from either station 7+50 or the existing embankment on the east side of Courthouse Lake. See the response to comment 9 regarding the wick drain design and additional analyses required to refine the design. Design refinements will be delayed until borrow material strengths become available.

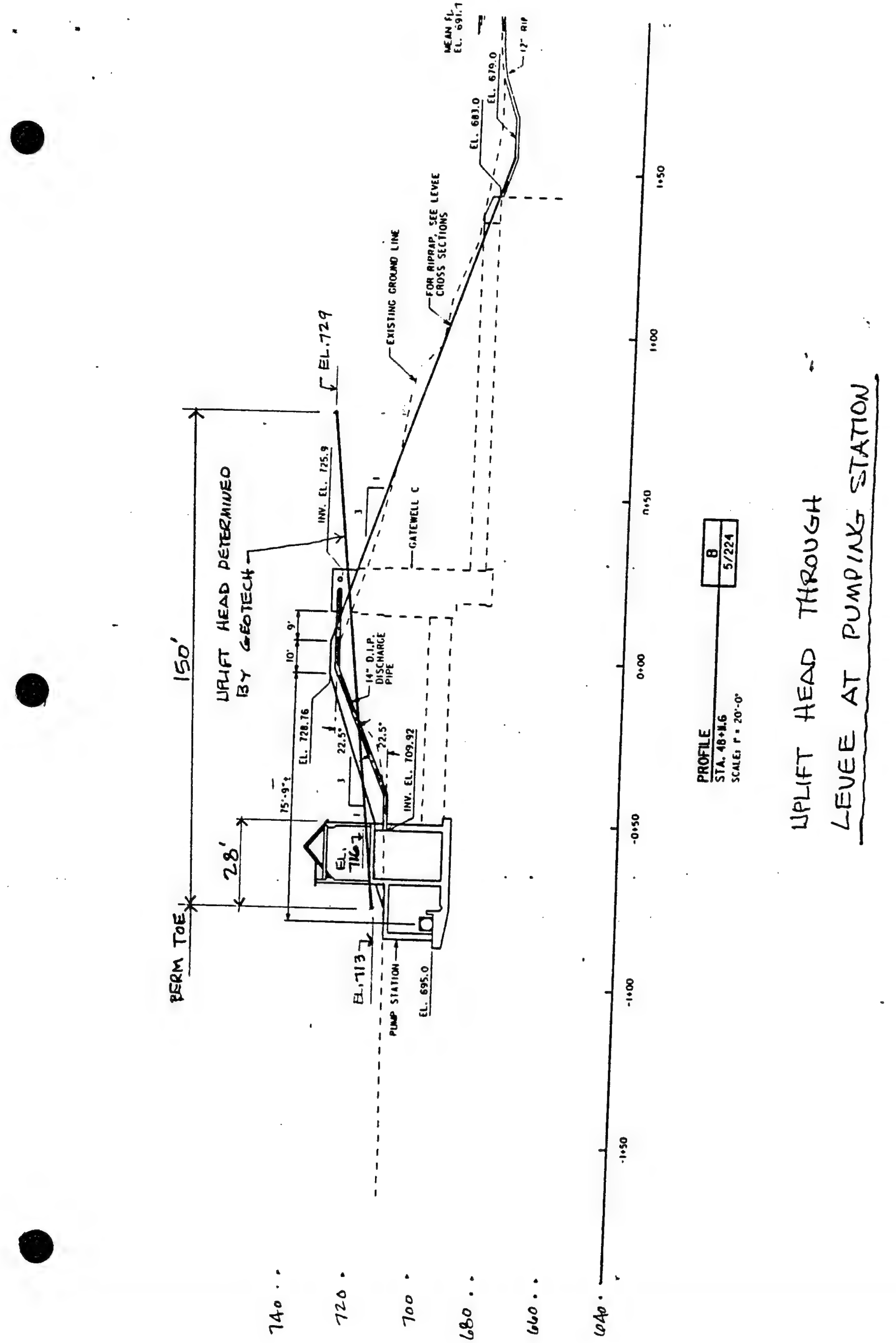
37. Simpson 17. Do not concur. Computations for wick drain spacing, etc. should have been included in the report but were unfortunately overlooked during final report preparation. See attached Table D for computations for the wick drain design shown in the report. The wick drains can not be eliminated unless the second stage construction can be delayed several years (see response to comment 7 regarding time rate of consolidation). Alternatives to wick drains were considered as described in paragraphs 25.a. through 25.c. on page C-7. Also note that the current design includes a drainage layer between the embankment and the foundation. For the suggested sandwich drains to be acceptable, the vertical sand drains described in paragraph 25.c. on page C-7 would have to be added. The wick drains are considered an economical, easily installed alternative to the vertical sand drains. A pervious toe trench and horizontal drain is not considered an acceptable alternative to relief wells at Chaska (see response to comment 14 regarding the suggested alternative).

FOR THE COMMANDER:

Robert F. Post

ROBERT F. POST
Chief, Engineering Division

Encl
Appendix G- Revised Table of Contents plus pages G-5 thru G-24
Attachment 1, Uplifthead at pump station
Revised page D-18
New page ii of appendix B
Tables A, B, C, and D



Attachment 1

Table A
Summary of soil strengths
East of Courthouse Lake
Soil layer #1

BORING	SAMPLE ELEV.	SPT	CLASS	LL	PL	Wc %	e	GAMMAd (pcf)	Gs	Q phi (degrees	Q c & tsf)
89 - 130	700.1	3	CH	63	33	49.9	1.23	72.0	2.57	0	0.15
83 - 63	698.1	3 TO 10	MH	57	32	62.7	1.61	63.9	2.60	0	0.15
83 - 62	698	3	CH	80	29	53.4	1.44	68.2	2.67	0	0.15
88 - 102	698	4	CH	50	19	36.0	1.00	84.5	2.70	0	0.25
89 - 119	697.8	2	CH	73	28	41.6	1.15	87.9	2.70	0	0.20
88 - 103	695.8	3	CH	69	24	48.0	1.30	72.5	2.67	0	0.15
82 - 41	694.85	2	OH	86	39	69.3	1.74	58.4	2.56	0	0.10
83 - 62	694.15	2	CL	31	14	36.1	0.93	86.1	2.66	0	0.20
89 - 130	694.1	2	CL	41	14	33.4	0.87	88.6	2.65	0	0.10
89 - 126	694	1	CH	64	49	40.8	1.06	81.2	2.66	0	0.10
83 - 63	690.1	4	OH	182	93	169.5	3.64	31.1	2.25	0	0.18
82 - 51	689.8	4	CH	116	31	67.0	1.68	58.7	2.51	0	0.25
82 - 41	689.7	2 TO 5	CH	81	32	74.0	1.93	55.7	2.60	0	0.10
89 - 119	688.8	1	CH	68	26	53.7	1.42	69.7	2.70	0	0.10
88 - 103	685.8	2	CH	56	23	40.7	1.09	80.4	2.69	0	0.30
89 - 126	684	2	CH	67	23	50.2	1.35	71.4	2.69	0	0.20
89 - 119	682.8	3	CH	69	23	44.4	1.21	75.9	2.69	0	0.30
Average						57.1	1.4	70.9	2.6	0.0	0.17

Table B
Summary time/settlement data
East of Courthouse Lake
First stage of construction

PROGRAM CSETT - VERTICAL STRESS INDUCTION AND SETTLEMENT PROGRAM

II. OUTPUT SUMMARY.

1. TITLE- FILE: csett-2.b ** AVERAGE VALUES USED FOR ALL INPUT **

2. SUMMARY OF TIME SETTLEMENT DATA.

PLANE OF INTEREST: XRIGHT= -120.0
XLEFT= 120.0
DELX= 20.0

TIME (YR)	X=-120.0	X=-100.0	X= -80.0	X= -60.0	X= -40.0	X= -20.0
ULT.	0.120	1.202	2.206	2.643	2.683	2.691
0.25	0.016	0.162	0.298	0.356	0.362	0.362
0.50	0.022	0.230	0.421	0.504	0.513	0.513
1.00	0.032	0.324	0.594	0.714	0.725	0.726
5.00	0.073	0.722	1.321	1.585	1.608	1.612
10.00	0.097	0.964	1.771	2.118	2.152	2.157
20.00	0.113	1.143	2.098	2.514	2.555	2.561
40.00	0.120	1.200	2.198	2.637	2.677	2.682
78.55	0.120	1.202	2.206	2.643	2.683	2.691

TIME (YR)	X= 0.0	X= 20.0	X= 40.0	X= 60.0	X= 80.0	X= 100.0
ULT.	2.693	2.691	2.683	2.643	2.206	1.202
0.25	0.363	0.362	0.362	0.356	0.298	0.162
0.50	0.513	0.513	0.513	0.504	0.421	0.230
1.00	0.727	0.726	0.725	0.714	0.594	0.324
5.00	1.613	1.612	1.608	1.585	1.321	0.722
10.00	2.160	2.157	2.152	2.118	1.771	0.964
20.00	2.561	2.561	2.555	2.514	2.098	1.143
40.00	2.683	2.682	2.677	2.637	2.198	1.200
78.55	2.693	2.691	2.683	2.643	2.206	1.202

TIME (YR)	X= 120.0
ULT.	0.120
0.25	0.016
0.50	0.022
1.00	0.032
5.00	0.073
10.00	0.097
20.00	0.113
40.00	0.120
78.55	0.120

Table C

Input data for:

Summary time/settlement data

East of Courthouse Lake

First stage of construction

```
010  TITLE
020  FILE: csett-2.b  ** AVERAGE VALUES USED FOR ALL INPUT **
030  2DSO  1  6  0.0  0.0  119.0
040  -9999.  702.0  -113.0  702.0  -68.0  717.0  68.0  717.0  113  702.0
050  9999.  702.0
080  SOIL  1  702.0  S  110.8  0.065  38.61  0.32
090  INDE  .416  221.6  1.15
120  SOIL  2  698  C  48.4  0.065  38.61  0.32
130  INDE  .416  636.8  1.15
160  SOIL  3  690  C  40.6  0.068  20.93  0.32
170  INDE  .568  911.6  1.61
180  SOIL  4  686  C  46.2  0.067  18.64  0.32
190  INDE  .430  1142.6  1.29
200  SOIL  5  676  N  64.4
240  BOUS  40
250  TIMS  .25  .5  1  5  10  20  40  78.55
260  OUTP  -120  120  20
270  END
```

Table D
"Wick" drain calculations
East of Courthouse Lake
Design Cv exceeded by two-thirds of the test results

Designing with Geosynthetics
Robert M. Koener
Prentice Hall, 1988

6.4.2.Designing with geocomposites
Designing locations of "wick" drains
pg. 566
eq. 6.6 t=((D^2)/(8*Ch))*[((ln(D/d))/(1-(d/D)^2))-((3-(d/D)^2)/4)]*(ln(1/(1-U)))

Ch(ft^2/day)	0.07
Ch/Cv	2
Cv(ft^2/day)	0.035

Design spacing using AMERDRAIN 407 soil drainage wick
ficticious "d"=(2*l+2*w)/PI

d(ft)	0.21884
wick(diameter,"d")	2.62606
length(in)	0.125
width(in)	4

							spacing pattern square (ft)	triangular (ft)
t(days)	*	73.8123	202.022	245.199	319.011	490.398		
D(ft)	*	5	5	5	5	5	4.4	4.8
Ch(ft^2/day)	*	0.07	0.07	0.07	0.07	0.07		
d(ft)	*	0.21884	0.21884	0.21884	0.21884	0.21884		
U	*	0.5	0.85	0.9	0.95	0.99		

Ch(ft^2/day)	0.105
Ch/Cv	3
Cv(ft^2/day)	0.035

							spacing pattern square (ft)	triangular (ft)
t(days)	*	49.2082	134.681	163.466	212.674	326.932		
D(ft)	*	5	5	5	5	5	4.4	4.8
Ch(ft^2/day)	*	0.105	0.105	0.105	0.105	0.105		
d(ft)	*	0.21884	0.21884	0.21884	0.21884	0.21884		
U	*	0.5	0.85	0.9	0.95	0.99		

t(days)	*time for consolidation
D(ft)	*the sphere of influence of the strip drain(1.05*spacing for triangular pattern;1.13*spacing for square pattern)
Ch(ft^2/day)	*the coefficient of consolidation for horizontal flow
d(ft)	*equivalent diameter of the strip drain(circumference/PI)
U	*the average degree of consolidation

File: C:\ARMS\CHAS4DM2.CMT
Printed: Tuesday May 28, 1991 at 10:25:20 a.m.

Project Info: Chaska Stage 4 Design Memo #2

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
1	KORBUS	ED-TT	D-8	GEN STR	

Provide a sketch indicating how the uplift head, 28 feet from the berm toe was calculated.

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
2	KORBUS	ED-TT	D-8 TO D-26	GEN STR	

Include in all pump station wall design calculations the area of steel required and identify reinforcing selected. This is important for later review and verification of construction drawings.

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
3	KORBUS	ED-TT	D-8 TO D-26	GEN STR	

Provide a design sketch indicating structural features (walls and slabs) for which design calculations have been presented together with reinforcing to be provided. In the absence of such a sketch, it is difficult to readily identify the applicable wall or slab to be designed.

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
4	KORBUS	ED-TT	D-17	GEN STR	

Identify paragraph from EM 1110-2-3104 stipulating a safety factor of 5.0 for gate operator lifting force on forebay slab.

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
5	KORBUS	ED-TT	D-24	GEN STR	

Provide sketch indicating how uplift at berm toe (elev. 713 was calculated).

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
6	KORBUS	ED-TT	D-41	GEN STR	

Provide rationale for using Class III pipe for 72" RCP (D-load = 1590) inasmuch as the apparent D-load limitation for this class of pipe is 1350.

File: C:\ARMS\CHASKA.CMT
Printed: Tuesday May 28, 1991 at 1:24:36 p.m.

Project Info: Chaska Stage 4 FDM Cost Est.

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
1	TENKE-WHITE	PE-ED-TT	G-3	EST	

Discussed with Mike Osterby (Cost Eng. NCS) that in certain places the summary sheets did not appear to add correctly. The overall cost changes should be slight, however, they should be corrected to avoid problems in the future. Mik indicated that the contingency might be adjusted to arrive at the same bottom line figure. This is acceptable if the changes are small (<$100,000).

2	TENKE-WHITE	PE-ED-TT	G-8	EST

Item 11.0.1 - East Creek has a JOB value of $2,900. The summary sheet should reflect a better description to indicate what this activity is.

3	TENKE-WHITE	PE-ED-TT	G-21	EST

In the future, a more detailed breakdown of construction management activities will be required. A lump sum, one line description will not be acceptable. An appropriate contingency should be included in the contingency column (not included in the unit price). The cost shown also appears to be too low for a project of this type. The NCS should re-evaluate the CM requirements and revis accordingly.

4	TENKE-WHITE	PE-ED-TT	G-20	EST

The 30 Account has been presented in sufficient detail. However, it should be noted that the overall engineering cost is approximately 25% of the project's construction cost. This is excessive for a project of this nature.

5	TENKE-WHITE	PE-ED-TT	G-3	EST

Discussed this cost estimate with Real Estate and Construction. Real Estate ha no problem with the submitted material. Construction agrees with the comment that the amount in the 30 account is insufficient.

6	TENKE-WHITE	PE-ED-TT	G-3	EST

Recommend that this cost estimate be approved subject to the above comments.

File: C:\ARMS\CHASVEN.CMT
Printed: Thursday May 30, 1991 at 8:58:32 a.m.

Project Info: Chaska Stage 4 DM No. 2

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
1	VENTO	ED-WH	PG-1, PA 4	GEN	

"Pine" Street should be Chestnut Street Hwy. 41.

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
2	VENTO	ED-WH	PG.A-2,PA 11	GEN	

Question as to whether TP 40 rainfall be used for interior hydrology evaluation.

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
3	VENTO	ED-WH	PG.A-15	GEN	TABLE A-1

Point-rainfall-depth frequency curve, table A-1 values page A-15 do not agree entirely with plotted rule curves on Plate A-12; please check plots or correct table.

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
4	VENTO	ED-WH	PG.B-	GEN	

Where is table of contents for tables and plates?

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
5	VENTO	ED-WH	PG.B-3	GEN	TABLE 1

The SPF for the Minnesota River is shown as 165,000 cfs while in other parts o the report the value stated is 168,000 cfs.

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
6	VENTO	ED-WH	-GENERAL	GEN	

The report does not provide adequate information on the inability to incorporate the existing 2 pump stations into the permanent project. The issue is, can the existing pumping stations be modified to allow pumping against the higher head of the Corps project? Are the existing pumping stations located in the appropriate location to prpoerly function as part of the permanent project It may be possible to reduce the cost of the project by incorporating these pumps into the project.

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
7	VENTO	ED-WH	-GENERAL	GEN	

The reprot needs to provide additional data to indicate that the proposal for only 2 outlets in sections 2 and 3 is the most cost effective proposal for interior flood control. The current proposal requires relatively large flows t be conveyed by the interceptor during gravity conditions. The report needs to indicate if the extra cost of additional outlets (and incorporation of existin outlets into the project) would be compensated by the reduction in the cost of the pipe required for the interceptor. (Frequently interceptors are only used during periods of blocked gravity drainage).

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
	VENTO	ED-WH	-GENERAL	GEN	

The report proposes sizing the gravity outlets and interceptors to pass the SPF. This design parameter needs to be justified. Normally these components are sized to pass the 1% event and residual damages checked during the SPF.

3

File: C:\ARMS\CHAS4DM2.CMT
Printed: Tuesday May 7, 1991 at 3:06:15 p.m.

Project Info: CHASKA STAGE 4 DM NO. 2

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
1	WICKBOLDT	PE-PD-EC	-	ECO	

No comments

File: C:\ARMS\CHAS4DM2.CMT
Printed: Tuesday May 21, 1991 at 7:19:04 a.m.

Project Info: Chask Stage 4 DM No. 2

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail
1	SIMPSON	ED-TG	PA C-4,PA 17	GEO	

The existing embankment should be proof rolled before building on top of it.

2	SIMPSON	ED-TG	PA C-5,PA 21	GEO	

Since both the steady seepage case and the intermediate river stage cases require long flood durations to saturate the relatively impervious embankment, they do not appear to be viable cases. Comment on this situation.

3	SIMPSON	ED-TG	PA C-6,PA 22	GEO	

The soil strength after consolidation should be somewhere between the Q and R strength with a phi value. See Figure 3, page 14 of EM 1110-2-1902 and correct as necessary.

4	SIMPSON	ED-TG	PA C-6,PA 22	GEO	

Discuss if stress/strain curves of the embankment and soft foundation are significantly different so that adjustments should be made to strength values. See DM 7.01, dated 1 September 1986, page 7.1-332. The assumed equal strain concept may not be correct for this case.

5	SIMPSON	ED-TG	PA C-6,PA 22	GEO	

Strength values for normally consolidated soils should increase with depths. UTEXAS-2 input should reflect this. Verify that your results are correct or provide rationale that supports the data presented. It appears an average foundation soil strength of 400 psi is more likely.

6	SIMPSON	ED-TG	PA C-7,PA 25	GEO	

Restudy the assumed cracking depth of approximately 15 feet and other assumptions. A crack depth of between 7.5 to 10 feet may be more correct. If berms are used to limit lateral strain the crack depth may even be less. See formula on page 43 of Contract Report S-76-6, titled "The Role of Fill Strength in the Stability of Embankments on Soft Clay." Preliminary computations here gave a factor of safety of 1.2 for a crack depth of 7.5 feet. Other input was as follows:

a. End of construction
b. NCS soil strengths and location
c. Full levee height at Sta. 14+00; 30 ft wide and 5 ft deep berm.
d. Circle Tangent 675.0 ft
e. Circle Center 83.0; 775.0 ft
f. No search. It was found when allowing a computer search that the critical circle moved down the land ward slope toward a bearing capacity, situation not a slope stability problem. It was noted a foundation soil strength of 400 psi gives a factor of safety of 1.4.

15

File: C:\ARMS\CHAS4DM2.CMT
Printed: Tuesday May 21, 1991 at 7:19:12 a.m.

Project Info: Chask Stage 4 DM No. 2

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail

7 SIMPSON ED-TG PG C-7,PA 25 GEO
NCS computations for this lower bound, deeper than usual crack analysis, indicates that the end of construction case probably has a stablility Factor of Safety (FS)=1.0 or greater. Although less than the required FS=1.3 the gain in strength with consolidation could in a comparative short time period, make all stability cases acceptable. Furnish computations for time consolidation and discuss this approach.

8 SIMPSON ED-TG PG C-7,PA 25 GEO
Explain how the existing levees were constructed almost to the proposed levees height on the same foundation without apparent stability problems.

9 SIMPSON ED-TG PG C-7,PA 25 GEO
In several borings, soft clays were noted to be shallow (around elev. 680.0 and above) and bracketed by granular material that would provide rapid drainage for consolidation and the needed increase of strength. Explain why wick drains are necessary in these areas.

10 SIMPSON ED-TG PG C-7,PA 25 GEO
If the proposed embankment fill strength is greater than 1200 psf, the initial stability would be higher and the need for wick drains might be eliminated. This condition/alternative of more compaction and higher embankment strength should be evaluated.

11 SIMPSON ED-TG PG C-7,PA 25 GEO
Since slope failures would most likely occur during construction and could be remedied by the contractor, the economic consequences and flood risk of some sloughing could be limited. Therefore a factor of safety of greater than 1.0 but less than 1.3 might be tolerable for a limited time period. Comment on this aspect.

12 SIMPSON ED-TG PG C-7,PA 25 GEO
The district should reanalyze the soft foundation situation using one or more of the following alternatives to wick drains: increased compaction and embankment strength, controlled sequence of placement, stability berms, reduced cracking depth (stability berms should limit lateral strain so there would be little or no cracking), a sandwich drain of granular material between the new embankment and the soft foundation and one or two stage construction as necessary.

13 SIMPSON ED-TG PG C-8,PA 26 GEO
Explain CSETT input and time rate of settlement computations so this can be reviewed.

File: C:\ARMS\CHAS4DM2.CMT
Printed: Tuesday May 21, 1991 at 7:19:22 a.m.

Project Info: Chask Stage 4 DM No. 2

Num	Name	Office	Page/Sheet	Discipline	Rm/Detail

14 SIMPSON ED-TG PG C-9,PA 32 GEO
Relief wells should be eliminated if possible. The following, less costly, alternatives were not addressed in the DM No. 2 and should be investigated:

(a). Use of landside seepage berms with a width of berm plus the levee base width not greater that ten times the levee height, but in no case with a width less than 30 feet. (NCR has had success with this design in many similar situations along the Mississsippi River)

(b). A pervious toe trench and a horizontal drainage blanket as shown in EM 1110-2-1913, on page 5-4. This design should be verified using a flow net to to see if exit gradients and seepage quantities are manageable.

(c). A partially penetrating slurry trench that would not cut off flow of groundwater toward the stream.

15 SIMPSON ED-TG PG C-9,PA 32 GEO
Discuss foundation selection, bearing capacity, etc. for all significant structures.

16 SIMPSON ED-TG PG C-7,PA 25 GEO
It was noted of the 14 borings in the soft areas where wick drains are proposed (between stations 7+50 and 30+50), that only 5 have questionable soil strength for stability. Justify wick drains for the entire reach.

17 SIMPSON ED-TG PG-C12,PA 46 GEO
Enclosed for guidance in design are the following:

a. Pages 190 through 194 of "Seepage, Drainage and Flow Nets," by Cedergren for wick drain design. It was noted that wick drain design was incomplete as computations for spacing, time of consolidation, flow rate, etc. were not found. However, wick drains should be eliminated if possible as per the above comments.

b. Sketch of sandwich drains to relieve construction pore pressures. This is a possible alternate to wick drains.

c. Typical flow net for a section having a pervious toe trench. This would be an alternate to relief wells.

plane flow is very limited, and usually cannot exceed a few percent, or more than several feet in a horizontal distance of 100 ft. The comparison is made as follows:

Flow Across the Plane of a Fabric (Transverse Flow):

Assume a 12-in. × 12-in. area, for $a_l = 1.0$ sq. ft.
Assume an allowable hydraulic gradient $i_l = 5.0$.

$$\text{Then, } q_l = k_l i_l a_l = k_l\,(5.0)\,(1.0) = 5.0k_l$$

Flow Along the Plane of a Fabric (In-Plane Flow):

Assume 1/8 in. thickness and a 12-in. wide strip, for $a_2 = 0.01$ sq. ft.
Allow a hydraulic gradient of 0.05 (5 ft. of head loss/100 ft.) for $i_2 = 0.05$

$$\text{Then, } q_2 = k_2 i_2 a_2 = k_2\,(0.05)(0.01) = 0.0005\,k_2$$

Ratio of Flow Rate Along Plane of Filter Fabric to Flow Rate Across:

Assuming that $k_l = k_2$:

$$q_2/q_1 = 0.0005/5 = 0.0001$$

So the flow rate along the plane of the fabric is 1/10,000 th of that across (for equal permeabilities in both directions).

Even if the hydraulic gradient *across* the fabric were limited to 1.0, the flow rate along the plane would be only 1/2,000th of that across. Clearly, filter fabrics that can serve well as filters to protect permeable drainage layers may be virtually useless as conveyors of water along their plane. So, too much should not be expected of filter fabrics for *in-plane* flow. Before such a usage is contemplated, the discharge needs should be calculated and no material used that cannot remove at least 4 or 5 times the estimated rate (for a theoretical factor of safety of at least 4 or 5).

Flow Capabilities of Composite Synthetic Drains

Composite Synthetic Drains (also called Prefabricated Drainage Composites) make use of high water-transmitting, high strength plastic cores enveloped within fabric filters. There are many varieties of composite drains used for a wide range of purposes. Some are for protecting walls and floors of basements from groundwater seepage. A type called *wick* drains is used as a replacement for the conventional sand drain for increasing the rate of consolidation of soft, compressible clay and peat foundations for embankments, as described in Sec. 7.2 under "Vertical Drains". Wick drains have a strong inner core with

high vertical discharge capability, wrapped within a fabric filter strong enough to resist forces produced when they are driven into the ground. They are driven vertically downward with special vibrating tools into soft formations that need to be rapidly consolidated so embankments can be placed over the formations after a reasonable consolidation period under partial load, without the danger of failing.

Another very common type of composite drain, sometimes called the *fin* drain, uses a strong plastic core with high vertical transmissibility that conducts seepage to a collector-discharge pipe at the bottom for removal to safe exits. The whole assembly is wrapped within a fabric filter. One of the first of this kind—if not the first—was developed by and patented by Healy and Long (1971). They used a core of corrugated or otherwise formed plastic material to provide vertical channels for downward conduction of water to the pipe at the bottom. A fabric filter enclosed the whole assembly. They emphasize that the cross-sectional area of the channels must be larger than the openings in the fabric to allow the few particles that wash through the fabric to wash into the pipe and out of the system.

The use of two kinds of plastic materials in the composite drains offers a way to obtain high flow rates with synthetic drains. The effectiveness of the composite drains lies in the fact that they are a *two-material system,* with one material serving as a filter and another as a water-conducting element. As with mineral aggregates, it is virtually impossible to achieve both good filtering and high water-removing capability with a single material (see Sec. 5.1). Effective water removal with the composite drains depends on a core structure that has high strength and contains rather large passageways for the water to travel freely to a pipe or other exit. Because this kind of drain is relatively thin in comparison with a trench backfilled with permeable aggregate, the discharge capabilities of some of the composites are in a relatively low range. Others that have high compressive strength and flow channels with effective diameters of 0.5 in. and greater, can have large flow capabilities.

Before designing a drainage system making use of composite drains, the engineer should make his best estimates of the quantities of water that need to be removed, using Darcy's law ($q = kiA$) with realistic coefficients of permeability of the formations from which water flows, hydraulic gradient inducing the flow, and the area through which water is flowing to a pipe drainage system. Then materials for core, and size of pipe should be selected with manufacturer's ratings (or user's tests) of discharge capabilities of the materials to be used.

To illustrate the basic capabilities of vertical composite drains for removing water, I prepared Table 5.3 for several sizes of flow channels and several ranges of "effective" or "quasi" coefficients of permeability of core materials. Hydraulic gradients (in the drains) range from 0.02 to 1.0. For vertically downward flow the gradient can be 1.0 (100%), but for other flow conditions it may be as low as 1 or 2 percent. Though it is based on hypothetical conditions, I believe Table 5.3 illustrates the general order of magnitude of flow

TABLE 5.3 Estimated Flow Rates for Composite Drains with Highly Permeable Cores

Effective flow channel dia., in.	Thickness, in.	Estimated turbulence factor, C	Estimated "quasi" k', ft/day	Hydraulic gradient, i	Estimated flow rates* cu ft/day per foot	Estimated flow rates* gpm per foot
0.25	0.3	0.20	16,000	1.0	360	2.0
		0.27	23,000	0.5	258	1.34
		0.50	33,000	0.1	74	0.39
		0.65	50,000	0.05	56	0.29
		0.90	80,000	0.02	36	0.19
0.5	0.6	0.16	60,000	1.0	2700	14.0
		0.21	78,000	0.5	1760	9.2
		0.42	156,000	0.1	700	3.6
		0.55	206,000	0.05	464	2.4
		0.86	320,000	0.02	290	1.5
0.8	1.0	0.12	100,000	1.0	7500	39.1
		0.16	134,000	0.5	5025	26.1
		0.36	300,000	0.1	2750	11.7
		0.50	416,000	0.05	1560	8.1
		0.85	610,000	0.02	915	4.8

*Approximations, based on Quasi Darcy k values obtained for turbulent conditions (see Fig. 3.30) and $q = k'iA$, with the effective discharge area, A, equal to 90% of the cross-sectional area of a composite drain. Each composite drain type should be tested for its flow rate for specified hydraulic gradient and confining pressure.

possible in composite drains. The sketches in Figure 5.14 show basic arrangements for two kinds of prefabricated composite fabric drains. A "fin" drain with downward flow to a collector-discharge pipe is shown in Figure 5.14*a*, and so-called "wick" drains with upward flow are shown in Figure 5.14*b*. A schematic cross section for drains of these kinds is given in Figure 5.14*c*. The calculated flow rates, as given in Table 5.3 are for hydraulic gradients ranging from 1.0 to 0.02 and effective flow channel diameters of 0.25 in., 0.50 in., and 0.80 in.

In Table 5.3 it can be seen that for downward flow under a hydraulic gradient of 1.0 in a vertical drain with a thickness of 0.3 in. and an effective flow channel diameter of 0.25 in. the potential rate of flow is 2 gpm per foot. For a 100-ft length of drain, the flow capability would be 200 gpm, which is a substantial amount of water. If one of these drains was installed in a sandy soil with a coefficient of permeability of 50 ft/day, and a hydraulic gradient of 0.5 inducing flow to the drain, the inflow into a 20-ft deep drain would be about 5 gpm per 100 ft. from one side.

Referring again to Table 5.3, it is seen that the upward flow rate for a drain with a quasi coefficient of permeability of 80,000 ft/day and a hydraulic gradient, i = 0.02, would be 0.19 gpm per foot of width, or 0.063 gpm for a

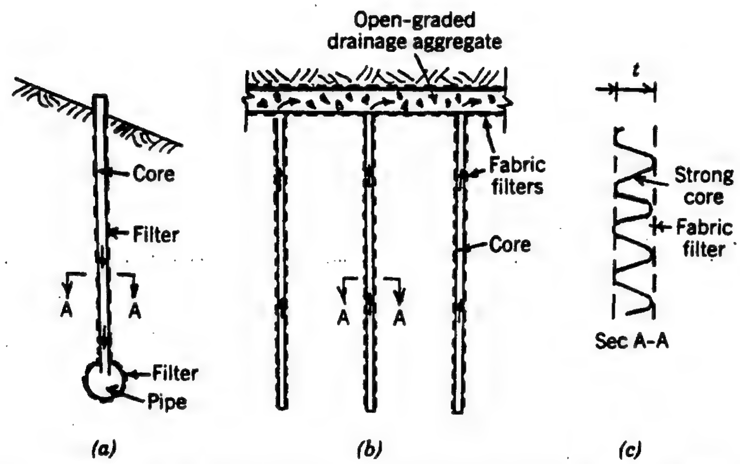


FIG. 5.14 Illustration of two kinds of composite synthetic drains, (*a*) Fin drain, (*b*) Wick drains, (*c*) shematic section *A-A* through typical prefabricated drain.

4-in wide wick drain. This would be 91 gallons per day or 12 cu ft/day for a single drain. Each cubic foot of water removed from a wick drain represents that amount of consolidation of the soil within its influence. With drains at a 4-ft spacing in both directions, 12 cu ft/day would represent (12 cu ft/day)/(16 sq. ft.) = 0.75 ft/day of consolidation, which is a very significant amount.

The flow rates in Table 5.3 are presented as rough indicators of potential rates for the conditions assumed. All prefabricated drains to be used in projects should have their capabilities tested before they are used to make sure they can perform as required.

Koerner (1986) made flow tests on a variety of "prefabricated drainage composites" using laboratory equipment that could handle up to 100 gpm per foot with applied normal pressures up to 30 psi for long periods of time. Fabrics with weak core structure had big reductions in flow under higher pressures, but three of the composites tested had large flow rates with little reduction under increasing pressure. One—measuring 2.8 cm in thickness with a core made up of columns of polyethylene 7 mm in diameter at 2 cm centers—had a flow rate of about 80 gpm under all pressures. Another—2.5 cm thick, with a "waffle" core of polystyrene—had flow rates of 12 to 11 gpm per foot under pressures from zero to 30 psi. The third—0.5 cm thick with a 0.75 cm grid of polypropylene for its core—had a flow rate of 2 gpm per foot, with no measurable reduction with increased pressure. All of the flow rates given here are for a hydraulic gradient of 1.0. Koerner concludes that more information is needed from manufacturers on flow rates of their products. He says specifications for composite drains should "list a minimum flow rate at a stipulated hydraulic gradient and applied pressure". Also, the protective filter "cannot intrude (much less fail) between the flow channels of the core material." His work is very timely as it gives answers to the key question about

prefabricated drains, "What is their capability for discharging water under field conditions?" As discussed at length in this chapter and elsewhere in this book, the discharge capabilities of all kinds of drains for engineering works is of prime importance.

Chen and Chen (1986) made tests on permeability characteristics of five prefabricated vertical drains and found that drain materials with thicker and harder cores had higher permeabilities than thinner and weaker core materials. Also, the large flow channels gave higher permeabilities than smaller ones. They found that Calhoun's criterion, $O_{95}/d_{85} \leq 2$ or 3, was better than another criterion that had been suggested. With soil confinement they obtained permeability values in the range of 11–21 cm/sec at 0.2 Kg/cm^2 pressure to 8–15 at 3.0 Kg/cm^2 confining pressure. Without soil confinement they obtained permeabilities in the range of 18-30 cm/sec at 0.2 Kg/cm^2 pressure to 10–24 cm/sec at 3.0 Kg/cm^2 confining pressure.

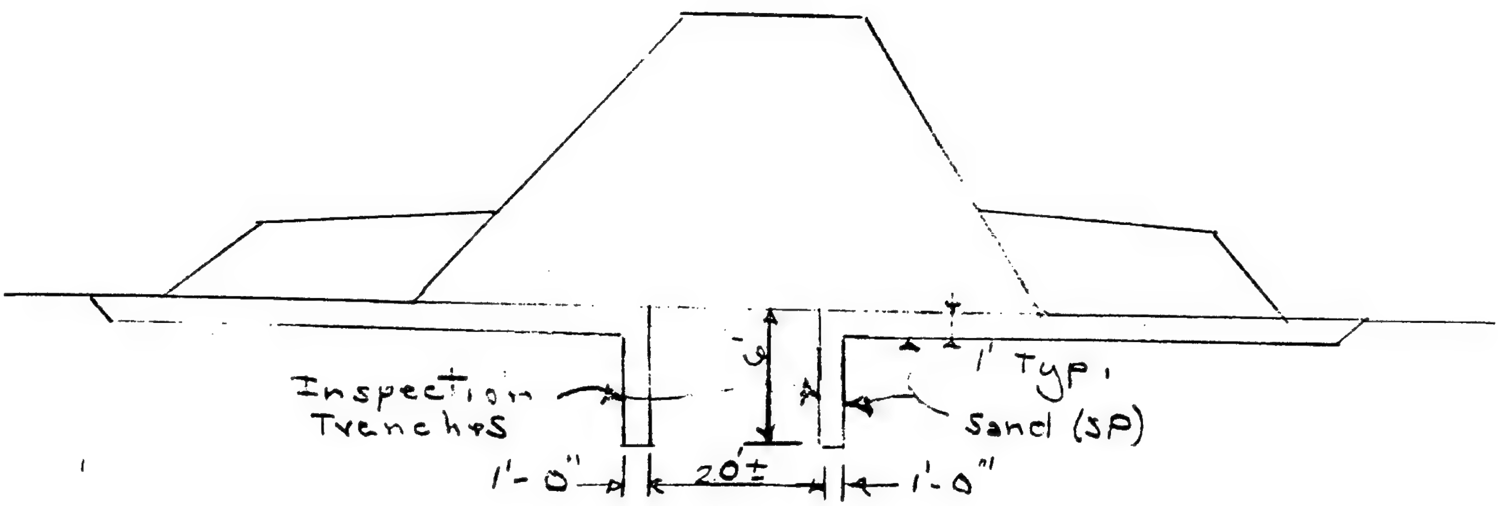
Suits (1986) describes procedures used by the New York State Department of Transportation (NYSDOT) to determine the acceptability of prefabricated wick drains. He concludes that rigid core drains lose very litle flow capacity under confining pressures, but soft core prefabricated drains lost 50% to 90% of their flow capacity under the same loads applied to those with rigid cores. Flows of 30 cc/sec to 210 cc/sec were obtained through rigid core drains. Like California Dept. of Transportation, New York State DOT requires that wick drains be installed with a protective mandrel. Spacings have been between 4 and 7 feet for three projects that all gave excellent performance.

Prysock and Walsh (1988) describe methods used by the California Department of Transportation (CALTRANS) to test prefabricated vertical drains for flow capacity characteristics to determine suitability for use. Sections of drain are immersed in water in a testing device that forces water to flow through the fabric and out through the core. A limiting pressure is set up for acceptance of any specimen proposed for use in a state project.

5.8 SPECIFICATIONS FOR AGGREGATE FILTERS AND DRAINS

Although naturally occurring gravels and sands can sometimes be used for filters and drains with little or no processing, drainage aggregates usually need to be treated. Efforts to save money by using untreated local materials almost always produce marginal or unsatisfactory filters and drains. Most natural sand and gravel deposits are highly variable in grading from point to point in a borrow area or are covered or interbedded with silt and clay that is difficult to remove. Rarely, natural deposits of clean washed beach sands are potential sources of permeable materials for highway drainage. Other relatively uniform natural deposits which are located near projects can be looked on as possible sources. When feasible, local deposits should be explored with drill holes, test pits, and trenches and tested for grain-size distribution. Usually, however, *nat-*

Foundation
Sandwich Drains



Flow Net Example (not this project)

Compute Exit F. of S.

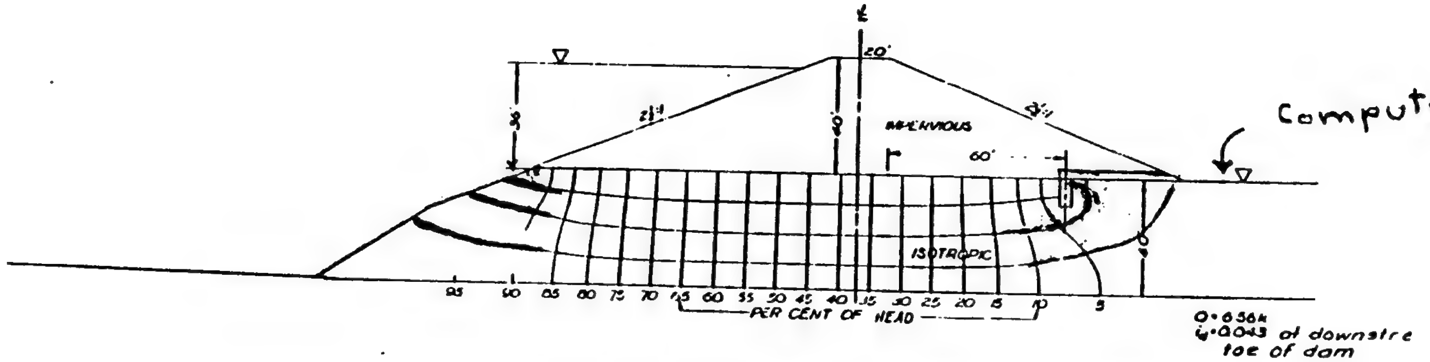
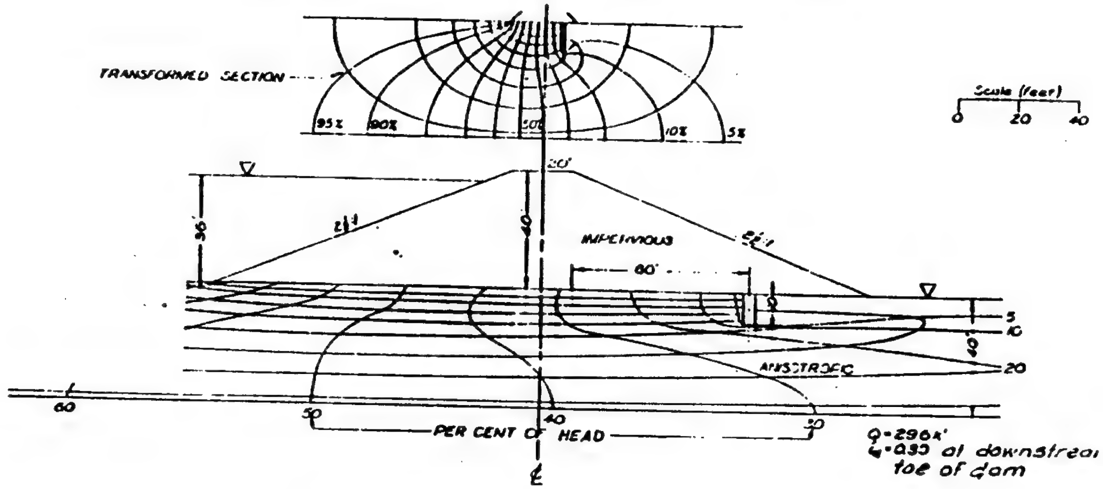


Figure 12-30. Flow net - isotropic foundation ($k_h=k_v$) with foundation trench drain at %=0.6



Note: An isotropic analysis is probably not necessary but should be considered if horizonal and vertical permeabilities differ significantly.

attachment No. 1

CENCD-PE-ED-TM (CECW-EP-E/21 Oct 91) (1110-2-1150a) 3d End
Mr. Ordonez/mgb/(312) 353-9057
SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota, Design Memorandum No. 2, Stage 4, Minnesota River

Commander, North Central Division, U.S. Army Corps of Engineers, 111 North Canal Street, Chicago, IL 60606-7205 23 JAN 1992

FOR HQUSACE (CECW-EP-E/Mr. Smith), WASH DC 20314-1000

1. Forwarded are NCS responses to your review comments on the DM. These responses have been reviewed by NCD staff and are satisfactory, except the response to comment 2a.

2. In order to provide a satisfactory response to comment 2a, NCD requested that the district conduct additional work to confirm that no hazardous or regulated materials are within the project area. The district agreed to do the work prior to the preparation of the plans and specifications. The items of work are listed in enclosure 4.

3. The HQ, NCD, POC is Mr. Jose Ordonez, (312) 353-9057.

FOR THE COMMANDER:

4 Encls
1-3. nc
Added 1 encl
4. as

JOHN P. D'ANIELLO, P.E.
Director, Engineering and
Planning Directorate

CF:
CENCS-ED-M (Mr. Hyerman) w/encl 4
CENCS-PP-PM (Mr. Raasch) w/encl 4

CECW-EP-E (CECW-EP-E/21 Oct 91) (1110-2-1150a) 4th End SMITH/tf/
(202) 272-8951
SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota, Design Memorandum (DM) No. 2, Stage 4, Minnesota River

21 FEB 1992

HQ, U.S. Army Corps of Engineers, Washington, DC 20314-1000

FOR Commander, North Central Division, ATTN: CENCD-PE-ED

The NCS responses to HQ review comments on the subject DM are satisfactory, except for the following:

We concur with the district that the level of detail for real estate requirements for this stage work is appropriate. The fact remains, however, that a more complete real estate section for the subject memorandum is appropriate. Future reports should include a comprehensive and concise real estate section addressing real estate requirements, costs, schedules, etc., in one place in the memorandum or report.

FOR THE DIRECTOR OF CIVIL WORKS:

4 Encls
wd all encls

JOHN A. McPHERSON, P.E.
Acting Chief, Engineering Division
Directorate of Civil Works

CENCD-PE-ED-TM (CECW-EP-E/21 Oct 91) (1110-2-1150a) 5th End
Mr. Ordonez/mgb/(312) 353-9057
SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota, Design Memorandum (DM) N. 2, Stage 4, Minnesota River

Commander, North Central Division, U.S. Army Corps of Engineers, 111 North Canal Street, Chicago, IL 60606-7205 18 MAR 1992

FOR Commander, St. Paul District, ATTN: CENCS-ED-M

1. Forwarded for your information and guidance.

2. The HQ, NCD, POC is Mr. Jose Ordonez, CENCD-PE-ED-TM, (312) 353-9057.

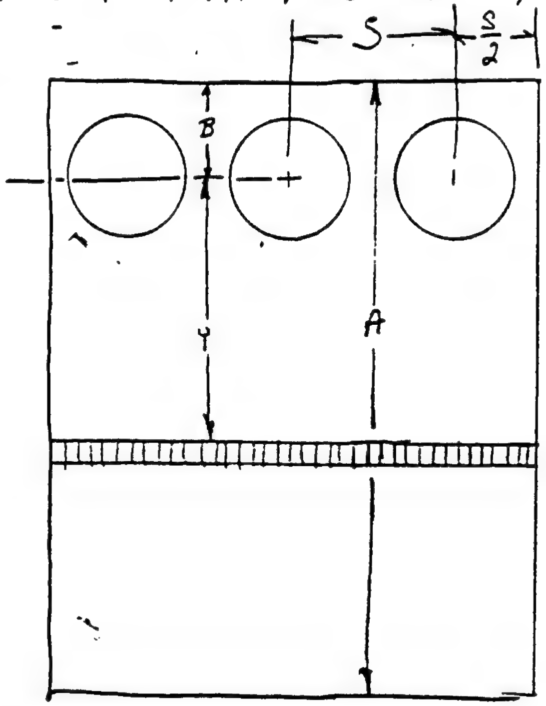
FOR THE COMMANDER:

Encl
nc

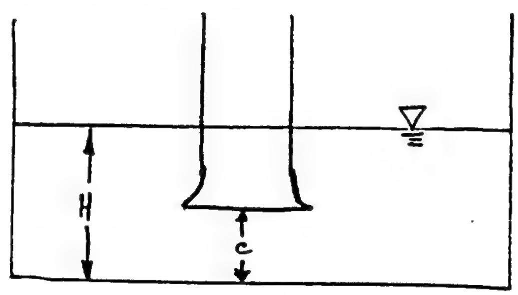
JOHN P. D'ANIELLO, P.E.
Director, Engineering and
Planning Directorate

CF:
CENCS-PP-PM (Mr. D. Raasch)

PRELIMINARY SUMP DIMENSIONS from "H.I.S. p 126



	6-8 kgpm	12-14 kgpm.
✓A	140	200
✓B	23 + (50)	33 + (50)
✓C	18	22.5
✓H	60	80
✓S	56	73.
✓Y	95	130



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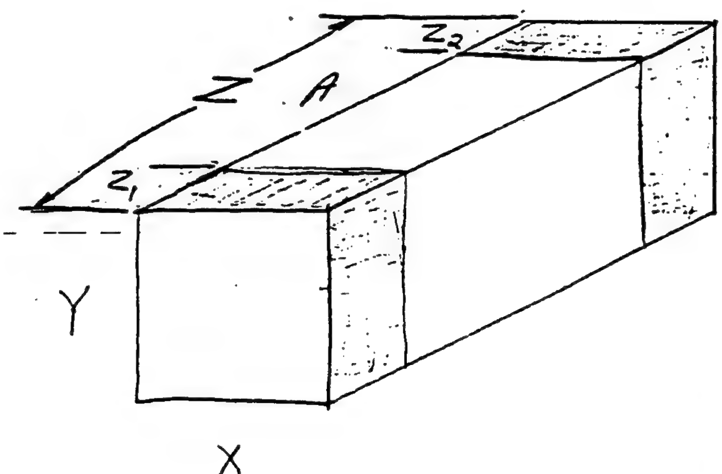


Z_1 - intreceptor chamber
Z_2 - discharge riser chambe

$Z_1 = 66'' + 12'' = 78''$

$Z_2 = 50''$

$\Delta Y = 13' = 156''$

ENCL #1

1ONELINE

1 PRI UTIL
ELL 13800

(U) CITY CHASK
UTILITY CONNECT

T 2 SEC
SZ KVA 500 | ELL 480
CL KVA 357.8

3 MCC
SZ 500 CM THWN | ELL 480
CL KVA 357.8

(M) PUMP 3
INDUCTION MOTOR

(M) PUMP 2
INDUCTION MOTOR

(M) PUMP 1
INDUCTION MOTOR

4 HEATER
SZ 12 CM THWN | ELL 480
CL KVA 10.0

5 PANEL
SZ 14 CN THWN | ELL 480
CL KVA 10.0

ENCL*2

DATE: 19 NOV 91 TIME: 4 49 PM PAGE: 2
MCC SCHEDULE: 3 MCC 3 PHASE 3 WIRE

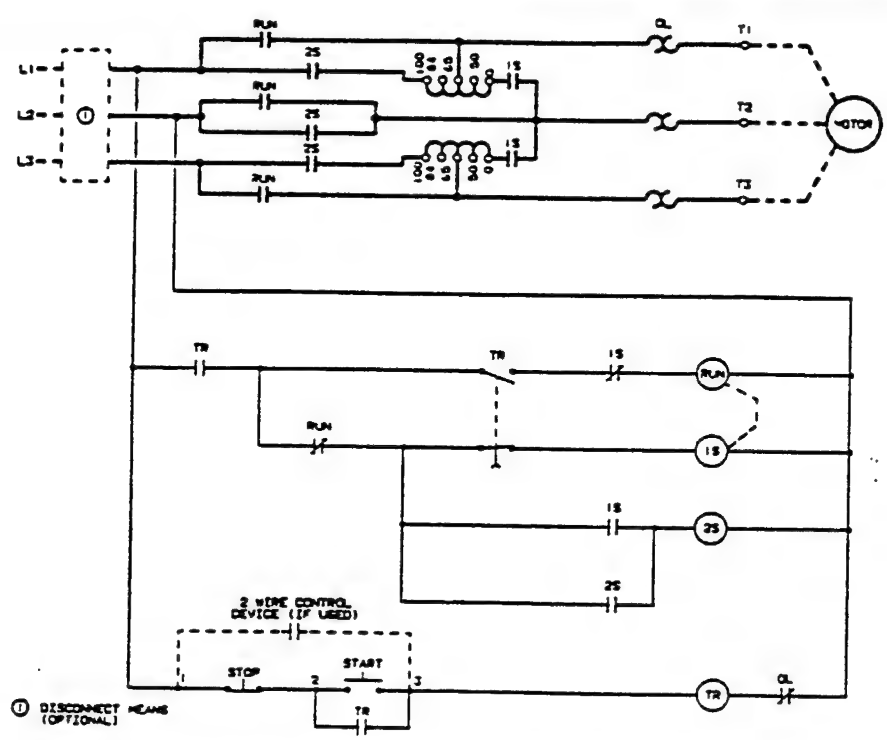
O.C. Device type: BREAKERS Mounting: FLOOR Voltage LL: 480
Device Family:] Enclosure: NEMA 1 Voltage LG:
Bus Amps: Comments: Fault Duty: 17814

Ck No	Description/ Location	Hp Size	Fla	Dem Cd	*OC Device* Type	Amps	P	Starter Sz	Type	#X Sp	Ac Gp	Raceway/Fdr Sz
1	STORM WATER PUMP 1	100	124	10	MCP	250	3	5	FVNR	6X		2"C 3"2/0
2	STORM WATER PUMP 2	100	124	9	MCP	250	3	5	FVNR	6X		2"C 3"2/0
3	STORM WATER PUMP 3	100	124	9	MCP	250	3	5	FVNR	6X		2"C 3"2/0
4	SUMP PUMP	2	3.4	9	MCP	7	3	1	FVNR	2X		1/2"C 3#14
5	CRANE	2	3.4	9	MCP	7	3	1	FVNR	2X		1/2"C 3#14
6	SANITIARY PUMP 1	10	14	9	MCP	30	3	1	FVNR	2X		1/2"C 3#12
7	SANITIARY PUMP 2	10	14	9	MCP	30	3	1	FVNR	2X		1/2"C 3#12
8	$$HEATER	4	12									
9	$$PANEL	5	12									
10	SPACE											

TOTAL LOADS: CONNECTED KVA: 357.9 DEMAND KVA: 357.9 DESIGN KVA: 383.6
CONNECTED FLA: 430.4 DEMAND FLA: 430.4 DESIGN FLA: 461.4

REDUCED VOLTAGE CONTROLLERS

AUTOTRANSFORMER TYPE



Sizes 2-5 Reduced Voltage Autotransformer Controllers
with Closed Transition Starting

CHASKA STAGE 4

US ARMY CORPS OF ENGINEERS - ST. PAUL, MINNESOTA

DATE: 18 NOV 91
TIME: 2 18 PM

ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL
INTERPRETATION AND APPLICATION BY A REGISTERED
ENGINEER ONLY

DAPPER (LOAD FLOW AND VOLTAGE DROP MINI/MICRO VERSION 3.5 LEVEL 2.1)

US ARMY CORPS OF ENGINEERS - ST. PAUL, MINNESOTA

FEEDER DATA

FEEDER FROM NO NAME	FEEDER TO NO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	TYPE	DESCRIPTION DUCT	INSUL
2 SEC	3 MCC	2	480.	75. FT	500	C	M	THWN
IMPEDANCE:	.0294 + J	.0466 OHMS/M FEET						
3 MCC	4 HEATER	1	480.	30. FT	12	C	M	THWN
IMPEDANCE:	1.8700 + J	.0910 OHMS/M FEET						
3 MCC	5 PANEL	1	480.	30. FT	14	C	N	THWN
IMPEDANCE:	2.9700 + J	.0961 OHMS/M FEET						

SOURCE BUS THEVENIN EQUIVALENT IMPEDANCE: .007049418 + J .211482600 OHMS
Calculated From Largest 3-PHASE Fault Contribution

ENCL #3

DATE: 18 NOV 91 TIME: 2 18 PM
CHASKA STAGE 4

US ARMY CORPS OF ENGINEERS - ST. PAUL, MINNESOTA

TRANSFORMER DATA

PRIMARY RECORD NO NAME	VOLTS L-L	PRI FLA	* SECONDARY RECORD NO NAME	VOLTS L-L	SEC FLA	NOMINAL KVA
1 PRI UTIL	13800.	21.	2 SEC	480.	601.	500.0

IMPEDANCE: 1.0000 + J 4.8989 PERCENT

US ARMY CORPS OF ENGINEERS - ST. PAUL, MINNESOTA

BRANCH LOAD DATA

FROM BUS / TO BUS	BR. TYPE	CONSTANT KVA KVA	CONSTANT KVA %PF	CONSTANT Z KVA	CONSTANT Z %PF	CONSTANT I KVA	CONSTANT I %PF	FLOW DIR.
2 SEC								
3 MCC	FEEDER	357	-80.6					
3 MCC								
4 HEATER	FEEDER	10	-90.0					
5 PANEL	FEEDER	10	-90.0					
1 PRI UTIL								
2 SEC	TRANS.	357	-80.6					

US ARMY CORPS OF ENGINEERS - ST. PAUL, MINNESOTA

*** SOLUTION COMMENTS ***

SOLUTION PARAMETERS

PER UNIT DRIVING VOLTAGE : 1.0000
BRANCH VOLTAGE CRITERIA : 4.00 %
BUS VOLTAGE CRITERIA : 5.00 %
EXACT(ITERATIVE) SOLUTION : YES
TRANSFORMERS MODELED : YES

<<PERCENT VOLTAGE DROPS ARE BASED ON NOMINAL DESIGN VOLTAGES>>

TOF SIZE: 19

LARGEST LOAD: 338.21 KVA
CONVERGENCE CRITERIA: .017 KVA
LARGEST BUS MISMATCH 3 MCC 19.445 KVA
LARGEST BUS MISMATCH 3 MCC .813 KVA
LARGEST BUS MISMATCH 3 MCC .034 KVA
LARGEST BUS MISMATCH 3 MCC .001 KVA

```
DATE:18 NOV 91     TIME: 2 18 PM
CHASKA STAGE 4

US ARMY CORPS OF ENGINEERS - ST. PAUL, MINNESOTA

     BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS (BRANCH LOAD REPORT)
******************************************************************************
VOLTAGE EFFECT ON LOADS MODELED      TRANSFORMER VOLTAGE DROP MODELED
VOLTAGE DROP CRITERIA: BRANCH -  4.00 %   BUS -  5.00
PER UNIT DRIVING VOLTAGE - 1.0000


LOAD BUS:     1 PRI UTIL   DESIGN VOLTAGE: 13800 LOAD VOLTAGE: 13796 %VD:    .0
-------------------------                        VOLTAGE ANGLE:     .0 DEGREES
LOAD FROM: **** SOURCE        FEEDER AMPS:     15 VOLTAGE DROP:     0. %VD:  .00
PROJECTED POWER FLOW:    292. KW    226. KVAR    369. KVA    PF:    .79   LAGGING
LOSSES THRU FEEDER:        0. KW        0. KVAR        0. KVA


LOAD BUS:     2 SEC        DESIGN VOLTAGE:    480 LOAD VOLTAGE:    467 %VD:  2.8
-------------------------                        VOLTAGE ANGLE:   -1.4 DEGREES
LOAD FROM:     1 PRI UTIL     TRANSF AMPS:    444 VOLTAGE DROP:    13. %VD: 2.77
PROJECTED POWER FLOW:    289. KW    213. KVAR    359. KVA    PF:    .81   LAGGING
LOSSES THRU TRANSF:       2.7 KW    13.4 KVAR    13.6 KVA


LOAD BUS:     3 MCC        DESIGN VOLTAGE:    480 LOAD VOLTAGE:    465 %VD:  3.1
-------------------------                        VOLTAGE ANGLE:   -1.5 DEGREES
               NET BRANCH DIVERSITY LOAD:     271. KW     203. KVAR
LOAD FROM:     2 SEC          FEEDER AMPS:    444 VOLTAGE DROP:     1. %VD:  .31
PROJECTED POWER FLOW:    289. KW    212. KVAR    358. KVA    PF:    .81   LAGGING
LOSSES THRU FEEDER:        1. KW        1. KVAR        1. KVA


LOAD BUS:     4 HEATER     DESIGN VOLTAGE:    480 LOAD VOLTAGE:    464 %VD:  3.3
-------------------------                        VOLTAGE ANGLE:   -1.5 DEGREES
               NET BRANCH DIVERSITY LOAD:       9. KW       4. KVAR
LOAD FROM:     3 MCC          FEEDER AMPS:     12 VOLTAGE DROP:     1. %VD:  .23
PROJECTED POWER FLOW:      9. KW      4. KVAR     10. KVA    PF:    .90   LAGGING
LOSSES THRU FEEDER:        0. KW        0. KVAR        0. KVA


LOAD BUS:     5 PANEL      DESIGN VOLTAGE:    480 LOAD VOLTAGE:    463 %VD:  3.5
-------------------------                        VOLTAGE ANGLE:   -1.4 DEGREES
               NET BRANCH DIVERSITY LOAD:       9. KW       4. KVAR
LOAD FROM:     3 MCC          FEEDER AMPS:     12 VOLTAGE DROP:     2. %VD:  .37
PROJECTED POWER FLOW:      9. KW      4. KVAR     10. KVA    PF:    .90   LAGGING
LOSSES THRU FEEDER:        0. KW        0. KVAR        0. KVA
```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US ARMY CORPS OF ENGINEERS - ST. PAUL, MINNESOTA

     BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS (BRANCH LOAD REPORT)
******************************************************************************
VOLTAGE EFFECT ON LOADS MODELED      TRANSFORMER VOLTAGE DROP MODELED
VOLTAGE DROP CRITERIA: BRANCH -  4.00 %   BUS -  5.00
PER UNIT DRIVING VOLTAGE - 1.0000
```


```
   5 BUSES

*** T O T A L   S Y S T E M   L O S S E S ***
           3. KW        14. KVAR
```

Chaska, MN Flood Control
Scope of Additional Work to Determine
Presence/Absence of Hazardous or Regulated Materials
Within Project Area

St. Paul District determined that no known commercial or industrial establishments were located in the considered project area. St. Paul District will do the following to confirm that no hazardous, toxic, radiological nor regulated materials are within the considered project area:

a. The project will be coordinated with all applicable agencies, including the U.S. EPA, Minnesota Pollution Control Agency, the county and municipal agencies, to determine if they know or suspect any contaminated areas.

b. The site will be inspected when weather permits by personnel experienced in identifying potential contaminated areas. (This inspection will be similar to a DERP FUDS preliminary assessment). Suspect areas such as land fills, burn areas, abandoned industrial sites, utility lines or crossings, underground tanks or piping, areas with distressed vegetation, /etc. will be identified.

c. The above investigations will be documented to determine the need for any further investigations. The local sponsor, current owner and all applicable regulatory agencies will be informed of suspect areas requiring additional investigation and a scope of additional investigations will be developed as required.

d. The findings of the planned investigation, including the scope and estimate of additional studies required, will be documented in an addendum to the Design Memorandum and submitted to this office for review.

e. The above effort will be completed prior to completion of plans and specifications.

Encl 4

12 AUG 1991

CENCD-PE-ED-TM (CENCS-ED-M/24 Apr 91) (1110) ~~2nd~~ 3rd End
Mr. Ordonez/amw/(312) 353-9057
SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota, Design Memorandum No. 2, Stage 4, Minnesota River

Commander, North Central Division, U.S. Army Corps of Engineers, 111 N. Canal Street, Chicago, IL 60606-7205

FOR Commander, St. Paul District, ATTN: CENCS-ED-M

1. Your responses to CENCD review comments are satisfactory. The subject Design Memorandum is approved.

2. The HQ, NCD, POC is Mr. Jose Ordonez, (312) 353-9057.

FOR THE COMMANDER:

2 Encls
nc

JOHN P. D'ANIELLO, P.E.
Director, Engineering and
Planning Directorate

CF:
CECW-EP (w/ 10 copies encl 1)

CENCD-PE-ED-TM (CENCS-ED-M/24 Apr 91) (1110) ~~2nd~~ 3rd End
Mr. Ordonez/amw/(312) 353-9057
SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota, Design Memorandum No. 2, Stage 4, Minnesota River

Commander, North Central Division, U.S. Army Corps of Engineers, 111 N. Canal Street, Chicago, IL 60606-7205

FOR Commander, St. Paul District, ATTN: CENCS-ED-M

1. Your responses to CENCD review comments are satisfactory. The subject Design Memorandum is approved.

2. The HQ, NCD, POC is Mr. Jose Ordonez, (312) 353-9057.

FOR THE COMMANDER:

2 Encls
nc

JOHN P. D'ANIELLO, P.E.
Director, Engineering and
Planning Directorate

CF:
CECW-EP (w/ 10 copies encl 1)

CENCD-PE-ED-TM (CENCS-ED-M/24 Apr 91) (1110) 1st End
Mr. Ordonez/amw/(312)-353-9057
SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota, Design Memorandum No. 2, Stage 4, Minnesota River

Commander, North Central Division, U.S. Army Corps of Engineers, 111 N. Canal Street, Chicago, IL 60606-7206 **11 JUN 1991**

FOR Commander, St. Paul District, ATTN: CENCS-ED-M

1. Approval of the subject report is held in abeyance until the enclosed CENCD comments are resolved.

2. The HQ, NCD, POC is Mr. Jose Ordonez, (312) 353-9057.

FOR THE COMMANDER:

2 Encl
wd encl 1
Added 1 encl
2. CENCD [illegible]

JOHN P. D'ANIELLO, P.E.
Director, Engineering and
Planning Directorate

Rec'd 19 JUN 91

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

TABLE OF CONTENTS

Item	Page	Paragraph
SCOPE AND LOCATION	1	1
PROJECT AUTHORIZATION	1	2
PROJECT DESCRIPTION - GENERAL	1	3
DEPARTURES FROM APPROVED GENERAL DESIGN MEMORANDUM	1	4
HYDROLOGY	1-2	5
GEOLOGY	2	6
DESCRIPTION OF PROPOSED STRUCTURES		
LEVEE	2	7
PUMPING STATION	2	8
PONDING AREA	2	9
OUTLETS	2-3	10
RELIEF WELLS	3	11
LANDSCAPING	3	12
RECREATION	3	13
RELOCATIONS		
UTILITIES, ROADS	3-4	14-15
SANITARY SEWER AND LIFT STATION	4	16
ENVIRONMENTAL ANALYSIS		
ENVIRONMENTAL SETTING	4	17
ENVIRONMENTAL IMPACTS	4-5	18-21
CULTURAL RESOURCES	5-6	22-25
CONSTRUCTION MATERIALS		
GENERAL	6	26
LEVEE FILL	6	27
RIPRAP AND BEDDING	6	28
CONSTRUCTIBILITY	6	29
REAL ESTATE REQUIREMENTS	7	30-32
MEASURES FOR PHYSICAL SECURITY	7	33
CORROSION MITIGATION	8	34
WATER QUALITY	8	35-36

25	OUTLET C, SITE PLAN
26	SITE PLAN AND PERSPECTIVE SKETCHES
27	LAYOUT PLANS
28	LAYOUT SECTIONS
29	LAYOUT SECTION AND DETAILS
30	ELECTRICAL 3 PUMP CONTROL DIAGRAM
31	COURTHOUSE LAKE TRAIL, GENERAL PLAN & SECTION

APPENDIXES

Letter	
A	INTERIOR FLOOD CONTROL
B	HYDRAULIC
C	GEOTECHNICAL DESIGN
D	STRUCTURAL
E	ARCHITECTURAL MECHANICAL ELECTRICAL
F	CONSTRUCTIBILITY
G	COST ESTIMATE

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

MAIN REPORT

SCOPE AND LOCATION

1. The flood control project at Chaska, Minnesota is divided into four stages of construction. This Design Memorandum (DM) presents the design and discussion of planning for Stage 4 which in general consists of a levee that protects Chaska from flooding of the Minnesota River. Work to be done includes approximately 4,200 feet of existing levee upgrading, 2,800 feet of new levee, one 18,000 gpm pumping station, 2 outlets with gatewells, interceptor pipe with manholes and inlets, relief wells and sanitary sewer with lift station.

PROJECT AUTHORIZATION

2. This project was authorized for construction under Public Law 94-587.

PROJECT DESCRIPTION - GENERAL

3. The Chaska Flood Control project consists of the following four stages:

a. Stage 1, Road raise along Chaska Creek.

b. Stage 2, Chaska Creek Diversion Channel.

c. Stage 3, East Creek Diversion Channel.

d. Stage 4, Minnesota River Levee.

Also included are recreational improvements, an environmental mitigation plan, and aesthetic consideration.

DEPARTURES FROM APPROVED GENERAL DESIGN MEMORANDUM

4. The design presented here essentially conforms to that shown in the General Design Memorandum, revised August 1984, except that the pumping station will be located at the end of Oak Street instead of Pine Street.

HYDROLOGY

5. Hydrologic information for this project is given in the Limited Reevaluation Report, August 1982. An elevation-frequency curve is presented there. No additional hydrologic analysis was required for this stage. The

levee is designed for the 1 percent chance flood and it will contain the water surface profile for the Standard Project Flood of 168,000 cfs for the Minnesota River at Chaska.

GEOLOGY

6. A discussion of the geology for the project area is given in appendix C of this report.

DESCRIPTION OF PROPOSED STRUCTURES

LEVEE (Sheets 2 thru 13)

7. The levee construction will consist of about 4,200 feet of existing levee upgrading and about 2,800 feet of new levee. The levee upgrading portion will consist of increasing the existing levee height by about 3 feet. The new levee portion will be about 25 feet high. The levee design is discussed in appendixes B and C.

PUMPING STATION (Sheets 25 thru 30)

8. A pumping station having a capacity of 18,000 gallons per minute will be located at the south end of Oak Street. It's superstructure will house the motor control centers for the storm water pumps and adjacent sanitary lift station, will act as the hub for all city flood control operations and maintenance, and will provide for storage of flood control equipment, materials, and supplies. The pump station design is discussed in appendixes A, D, and E.

PONDING AREA (Sheet 1)

9. A storm water ponding area at Outlet A will be provided. This ponding area will be in the existing Chaska Creek just upstream from Outlet A. Outlet A was constructed during Stage 2 construction. About 1.7 acre feet of storage between elevations 713.5 and 718.5 will be provided. This will require about 1.55 acres of ponding easements. The sides of the ponding area will be graded, topsoiled and seeded so that the area can be maintained. Ponding markers will be added as required.

OUTLETS (Sheets 21 thru 24)

10. Two outlets will be constructed to convey interior storm water through the levee to the Minnesota River. Twin 48" RCP's extending from the gatewells are recommended instead of a single pipe to:

a. Eliminate the need for a large concrete energy dissipater.

b. Eliminate freezing in the pipes by keeping their crowns below the normal low water line.

c. Eliminate sedimentation in the pipes by keeping their inverts above the bottom of the river.

The outlet design is discussed in appendix A.

RELIEF WELLS (Sheet 20)

11. Relief wells will be constructed just landward of the levee between about Stations 36+50 and 61+00. Relief wells are required to limit uplift pressures at the toe of the levee to acceptable values. The relief well design is discussed in appendix C.

LANDSCAPING

12. The levee and surrounding project area will be restored and landscaped. The location and proximity of the surrounding residential or other land uses will dictate the need for vegetative screening and provisions for enchancing or directing views. Design consideration will include the ease of maintenance and the incorporation of plant material that will offer seasonal color, bloom, fruit, hardiness, and wildlife shelter and food values. Additional considerations will be providing shade for trail users and maintaining plant selections that are consistent with Stage 2. The levee will have turf grasses established, with blue grass mixtures on the landward side for aesthetics purposes and prairie-type mixtures on the river side for wildlife purposes. In areas where it is deemed desirable to provide shrubs or shade on the levee, overburden will have to be provided to allow planting.

RECREATION

13. A multi-use trail will be provided on the top of the levee and around Courthouse Lake. It will consist of an 8-foot wide bituminous treadway with 1-foot wide aggregate shoulders. The trail will extend from and be continuous with the trail constructed in Stage 2. In the vicinity of Courthouse Lake, at approximately Station 29+00, a bituminous surfaced trail will be constructed linking the levee-top trail with a trail to be constructed around Courthouse Lake. From approximately Station 29+00 to Station 0+00, the levee-top trail's treadway will be stabilized aggregate during Stage 4 construction, with a bituminous trail added during Stage 3 construction. Lighting, safety rails, benches, trash receptacles will be provided as appropriate. Three informational kiosks will be provided; one near Courthouse Lake; one at the river access point near Cedar Street; and, one near the Chaska ballfield. The treadway will be fully accessible by mobility impaired visitors with the appropriate slopes and landings provided at major access points.

RELOCATIONS

UTILITIES, ROADS

14. As provided in the Local Cooperation Agreement (LCA), the Local Sponsor shall "accomplish or arrange for accomplishment at no cost to the Government of all alterations and relocations of buildings; highways; railroads; bridges (other than railroad bridges and approaches thereto); storm drains; utilities

(other than those portions which pass under or through the project structures); cemeteries; and other facilities, structures, and improvements determined by the Government to be necessary for construction of the project."

15. A table indicating the required utility modifications is given in appendix F. Three road relocations are required. These are in the area of Stations 7+00, 33+00, and 62+00.

SANITARY SEWER AND LIFT STATION

16. The existing sanitary sewer between Stations 34+00 and 71+00 will be relocated so that it is outside the levee and berm prism. It will be located just on the north side of the interceptor pipe. A sanitary lift station will be constructed in the area of the new storm water pump station at the end of Oak Street. This construction is classified as a relocation and as such is the Local Sponsor's responsibility to accomplish and pay for the design and construction. However, they will be given the option of:

a. Designing and constructing the relocation.

b. Designing the relocation and having it constructed with the Stage 4 flood control construction contract.

c. Having it designed with the Stage 4 plans and specifications and having it constructed with the Stage 4 flood control construction contract.

ENVIRONMENTAL ANALYSIS

ENVIRONMENTAL SETTING

17. Land use along this reach of the project is a mix of residential development, commercial development and undeveloped lands. The levee reach along Chaska Creek is adjacent to the Minnesota National Wildlife Refuge. On the riverward side of the existing levee and along the alignment for the levee extension, vegetation types are a mix of riparian woods, floodplain wetland, and old field. Riparian woods vegetation includes silver maple, American elm, box elder, cottonwood, and willow with an understory of nettle and grasses. The floodplain wetland can be characterized as a woodland pond within the riparian areas and is located just east of Courthouse Lake. Dominant vegetation of the old field vegetation type includes staghorn sumac, willow, goldenrod, and grasses. Vegetation along the landward side of the existing levee is characteristic of an urban setting with backyards, commercial development, and an occassional park area.

ENVIRONMENTAL IMPACTS

18. Construction of the proposed features will result in the loss of approximately 10 acres of riparian woods and three acres of old field. Habitat losses to wildlife with project construction are being partially mitigated with the planting of upland vegetation on project lands in conjunction with the construction of Stage 2 along Chaska Creek. Shrubs and shrubby tree species such as dogwood, hazel, and russian olive with oak,

wildplum, chokecherry, maple, and ash are being planted. These areas will be managed for wildlife.

19. Additional mitigation for losses associated with construction of this and other stages of the project will be provided with the construction of Fish and Wildlife features on the Minnesota Valley National Wildlife Refuge. The features include the construction of an outlet control structure for Chaska Lake and the construction of a 19 acre moist soil unit just to the east of Chaska Lake. The outlet control structure will provide the capability to manipulate water levels on the lake to control aquatic vegetation. The moist soil unit will be managed to provide feeding habitat for waterfowl. The area will be created by diking a 19 acre site that is currently cropland. The system will consist of two cells that can be flooded to a depth of about 2 feet and managed independently.

20. While preliminary designs of the above features have been developed, delays in the acquisition of surveys have delayed detailed design studies of specific features. Therefore, detailed design of the mitigation features will be done separately. The construction of the mitigation features will be done concurrently with construction of this stage of the project or it may be constructed earlier by a separate construction contract.

21. Design departures from what was described in the General Design Memorandum have been evaluated. The proposed changes would not result in any substantive changes in impacts from what was described in the Final Supplement to the Final Environmental Impact Statement, dated August 1982 or the Final Supplement II, dated February 1985. Therefore, additional NEPA documentation is not necessary.

CULTURAL RESOURCES

22. In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, the National Register of Historic Places has been consulted. A standing structure survey of Carver County conducted for the Minnesota State Historic Preservation Office in 1978 recorded 23 Historic National Register buildings and one National Register district in the City of Chaska. As of 13 December 1989, there are no sites listed on the National Register that will be affected by the proposed project. The buildings to be removed along the existing levee in connection with its upgrade have been evaluated by the staff of the Minnesota State Historic Preservation Office (MN SHPO) as being not eligible for listing on the National Register of Historic Places. As a result, there will be no affect on significant historic properties if any of the buildings are removed as proposed (per letter dated February 11, 1991 from MN SHPO).

23. The portion of the proposed Stage 4 levee along Courthouse Lake and East Creek was inventoried for cultural resources in 1985 as part of a project-related geomorphological and archeological investigation of the Minnesota River floodplain at Chaska. No cultural resources were encountered. In 1982, the Minnesota State Historic Preservation Office determined that the existing emergency levee along the south side of Chaska did not need a cultural resources survey as the project as then proposed would only affect extensively disturbed areas within the 10 feet of either side of the levee. Regardless,

in 1987, the floodplain area riverward of the existing emergency levee opposite Elm Street was surveyed for cultural resources as part of the Stage 2 Chaska Creek Diversion Stilling Basin then proposed for this area. No prehistoric or historic archeological resources were observed.

24. The remaining portions of Stage 4 of the Chaska Flood Control Project are scheduled for archeological and geomorphological investigation in the Spring of 1991. Contracting constraints prevented their survey in the Fall of 1990 as originally planned. The areas yet to be checked for cultural resources include the proposed stretch of levee northeast of Courthouse Lake and East Creek, the area where the existing emergency levee on the south side of Chaska between Hickory Street and Pine Street will be moved riverward, and the moist soil units on the Minnesota Valley National Wildlife Refuge east of Chaska Lake. The archeological survey will be coordinated with the Minnesota State Historic Preservation Office and in the case of the moist soil units, the U.S. Fish and Wildlife Service.

25. As presently proposed, borrow for levee construction will come from an existing commercial borrow area. If additional or alternate borrow areas are chosen for use with this project, they will have an archeological survey conducted at them prior to their use. The need for and results of such surveys will be coordinated with the Minnesota State Historic Preservation Office.

CONSTRUCTION MATERIALS

GENERAL

26. Concrete aggregate, berm and pervious fill and topsoil can be obtained from commercial sources in the area. See appendix C for additional discussion on construction materials.

LEVEE FILL (Sheet 1)

27. Impervious levee fill will be obtained from a commercial borrow area located about a mile from the project. This is the same borrow area provided by Chaska for the Stage 2 levee.

RIPRAP AND BEDDING

28. Riprap and bedding of adequate quality can be obtained from existing quarries located within 40 miles of Chaska.

CONSTRUCTIBILITY

29. Appendix F contains a discussion on the construction aspects of this project.

REAL ESTATE REQUIREMENTS

30. The City of Chaska will provide, without cost to the United States, and as generally provided by the Local Cooperation Agreement, all real estate interests, to include borrow and disposal areas, required for the construction, operation, and subsequent maintenance of the project. The City will also comply with all provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, as amended).

31. This stage of the Chaska Flood Control project will require the use of 58 acres of land, besides borrow and disposal areas, for project construction and maintenance. Real estate interests will be acquired from and/or credited to about 45 separate ownerships. Estates needed will be fee title, permanent easements, and temporary easements during construction. The following real estate costs were determined from right-of-way drawings and acreages provided by ED and include all reasonable amounts for acquisition of land and improvements, damages, and uneconomic remnants. Fee simple title has been designated for acquisition in lieu of permanent levee easements wherever proposed recreation trail features appear.

32. The costs are for all interests in land, improvements that include 8 residences and 18 garages or utility buildings privately owned, and damages to remaining property. A total of 45 separate ownerships are estimated.

Fee simple title (45) acres	$1,100,000	
Permanent levee easements (6 acres)	125,000	
Temporary construction area easements (7 acres)	68,000	
Subtotal (58 acres)		$1,293,000
Replacement housing/moving costs under Public Law 91-646, as amended		188,300
Administrative acquisition costs		
Local sponsor	55,000	
Federal	28,200	
Total administrative costs		83,200
Total contingencies		299,500
Total real estate estimate		$1,864,000

MEASURES FOR PHYSICAL SECURITY

33. Hatches at the gatewells and pump station would be secured with locks to prevent the public from entering and the pump station door will be lockable. The gatewells will have railings around them to prevent falls from them. Public access to the levee by vehicles will be prevented by removable guard post where roads cross the levee.

CORROSION MITIGATION

34. There is no evidence that corrosion due to the water and soils in the Chaska area is a problem. Therefore, no corrosion mitigation is planned.

WATER QUALITY

35. The fill materials placed in the river channel would be uncontaminated materials obtained from approved quarries and borrow areas. This should insure that water quality standards would not be violated because of project-related activities. Although some minor temporary increase of turbidity would occur during construction, levels of turbidity would return to normal after construction. No long term ponding of water, change of runoff characteristics, or operational procedures that would effect water quality woulld be associated with the project.

36. The provisions of Section 404 of the Clean Water Act have been met with the submission of the EIS Supplement, including a Section 404(b)(1) Evaluation, to Congress on 26 April 1982. The provisions of Section 404 were further met with the submission of the EIS Supplement No. 2, including a Section 404(b)(1) Evaluation in April 1985. The final EIS for Supplement No. 2 was filed in May 1985.

COST ESTIMATE

37. The cost estimate in this DM is based on current price levels and reflects recent prices for similar work done in the St. Paul District. The following table (Table 1) presents a cost estimate for Chaska, Stage 4 indexed to 1 October 1991 price levels and a comparison of the cost estimate with the current approved PB-3 estimate. Also shown is an estimate of the local share of the costs. The cost sharing is in accordance with the 1986 Water Resources Development Act (Public Law 99-662). Appendix G contains the detailed cost estimate for this project.

Table 1
Summary Comparison of Estimated First Costs

Item	Current Approved Estimate From PB-3 (1 October 1990)	Revised Estimate This DM (1 October 1991)
First Cost		
Land and Damages	$1,102,000	$2,060,000
Relocations		
Federal	0	0
Non-Federal	18,000	553,000
Levees and Floodwalls	3,121,000	5,477,000
Pumping Plants	555,000	648,000
Recreation Facilities	130,000	109,000
Planning, Engineering and Design	841,000	1,733,000
Construction Management	218,000	375,000
Total First Costs	5,985,000	10,955,000
Federal/Non-Federal		
Federal First Cost		
Flood Control	4,450,000	8,177,000
Recreation	77,000	66,000
Total	$4,527,000	$8,243,000
Non-Federal First Cost		
Flood Control	1,381,000	2,646,000
Recreation	77,000	66,000
Total	$1,458,000	$2,712,000

38. The difference in project first cost (an increase of $4,970,000) between this DM cost estimate ($10,955,000) and the current approved PB-3 ($5,985,000) is attributable to the following:

a. Price levels: +$202,000

b. Lands and Damages: +913,000

(1) Increase due to cost of impervious borrow from commercial source. +175,000

(2) Increase based on refined design and additional acquisition +888,000

(3) Decrease due to realignment of levee between stations 60+00 and 70+00 -150,000

c. Relocation: +534,000

(1) Increase due to the addition of the North, Beech, Cedar, and pedestrian ramps over the levee +155,000

(2) Increase due to the addition of a sanitary sewer, force main, lift station and manholes +340,000

(3) Increase due to the addition of miscellaneous utility modifications + 39,000

d. Levees and Floodwalls: +2,228,000

(1) Increase due to increase in the volume of impervious fill required +243,000

(2) Increase due to revision in unit cost of impervious fill + 63,000

(3) Increase due to revision in unit cost of relief wells +402,000

(4) Increase due to increase in number of relief wells +132,000

(5) Increase due to the addition of dewatering cost +445,000

(6) Increase due to the addition of riprap and bedding +346,000

(7) Increase due to the redesign of the outlets $229,000

(8) Increase due to an increase in the number of manhole and inlets +190,000

(9) Increase due to the addition of a traffic control cost +104,000

(10) Increase due to the addition of clearing and grubbing + 74,000

(11) Increase due to the additional landscaping + 40,000

(12) Increase due to miscellaneous changes in unit costs, quantities contingencies and design details +210,000

(13) Decrease due to realignment of levee between stations 60+00 and 70+00 - 50,000

(14) Decrease due to changing pump station location from Pine St. to Oak St. -200,000

e. Pumping Plant: +70,000

(1)	Increase due to the addition of a parking lot and other site work	+ 16,000
(2)	Increase due to more detailed design details	+ 54,000

f. Recreation Facilities: -26,000

(1)	Decrease due to deletion of bituminous surfacing between stations 0+00 and 29+00	- 26,000

g. Planning, Engineering, and Design: +882,000

(1)	Increase due to increase in construction cost	+659,000
(2)	Increase due to a reanalysis of the remaining design work required	+223,000

h. Construction Management: +150,000

(1)	Increase due to increase in construction cost	+150,000

CURRENT BENEFIT - COST ANALYSIS

39. The current Benefit/Cost analysis is based on the procedures used for updating project budgets. The last approved economic analysis of the Chaska Flood Control project was for the GDM dated February 1984 and is in October 1983 prices. Project first costs ($38,700,000 Oct 91) have been deflated from October 1991 price levels to October 1983 price levels ($32,244,000 Oct 83) using the ENR construction costs index. The factor is 0.8331. Interest during construction has been calculated using the same method as presented in the GDM report in which interest during construction is discontinued after completion of each stage.

<u>TABLE 1 BENEFIT/COST ANALYSIS</u>
(All figures are in October 1983 price levels)

<u>Federal</u>	
First Cost	24,169,000
Interest During Construction	2,536,100
Investment Cost	26,705,100
Annual Costs	2,342,000
<u>Non-Federal</u>	
First Costs	8,075,000
Interest During Construction	658,700
Investment Cost	8,733,700
Annual Costs	765,900
Annual Operation and Maintenance	42,000
<u>Total Investment Cost</u>	35,438,800
Total Annual Cost	3,149,900
8 3/4% 100 year project life	
Int & amort factor (.0877)	
Annual Benefits (1)	
Flood Control	2,232,000
Recreation	28,000
Total	2,260,000
Benefit Cost Ratio	0.72

(1) A cursory benefit analysis performed since the approved economic analysis indicates there is a potential for quantifying additional benefits. Additional benefits will be determined by the St. Paul District.

SCHEDULE FOR DESIGN AND CONSTRUCTION

DESIGN

40. Schedules for design and construction are based on the President's budget for Fiscal Year 1992. Plans and specifications are scheduled for completion in August 1992.

CONSTRUCTION

41. A continuing contract for Minnesota River Levees construction is scheduled for award in January 1993. Completion of construction is scheduled for August 1994.

FUNDING SCHEDULE

42. On the basis of the revised estimate for this DM and the current schedule presented in the President's FY-92 budget for completion of the project, the Federal funds required (by fiscal year) for construction are as follows:

a. Fiscal Year 1993 - $3,500,000

b. Fiscal Year 1994 - $3,830,000

OPERATION AND MAINTENANCE

43. Under the terms of the Local Cooperation Agreement, the local sponsor will be responsible for the operation and maintenance (O&M) of the project. An O&M manual will be provided to the local sponsor prior to final acceptance of the project by the local sponsor.

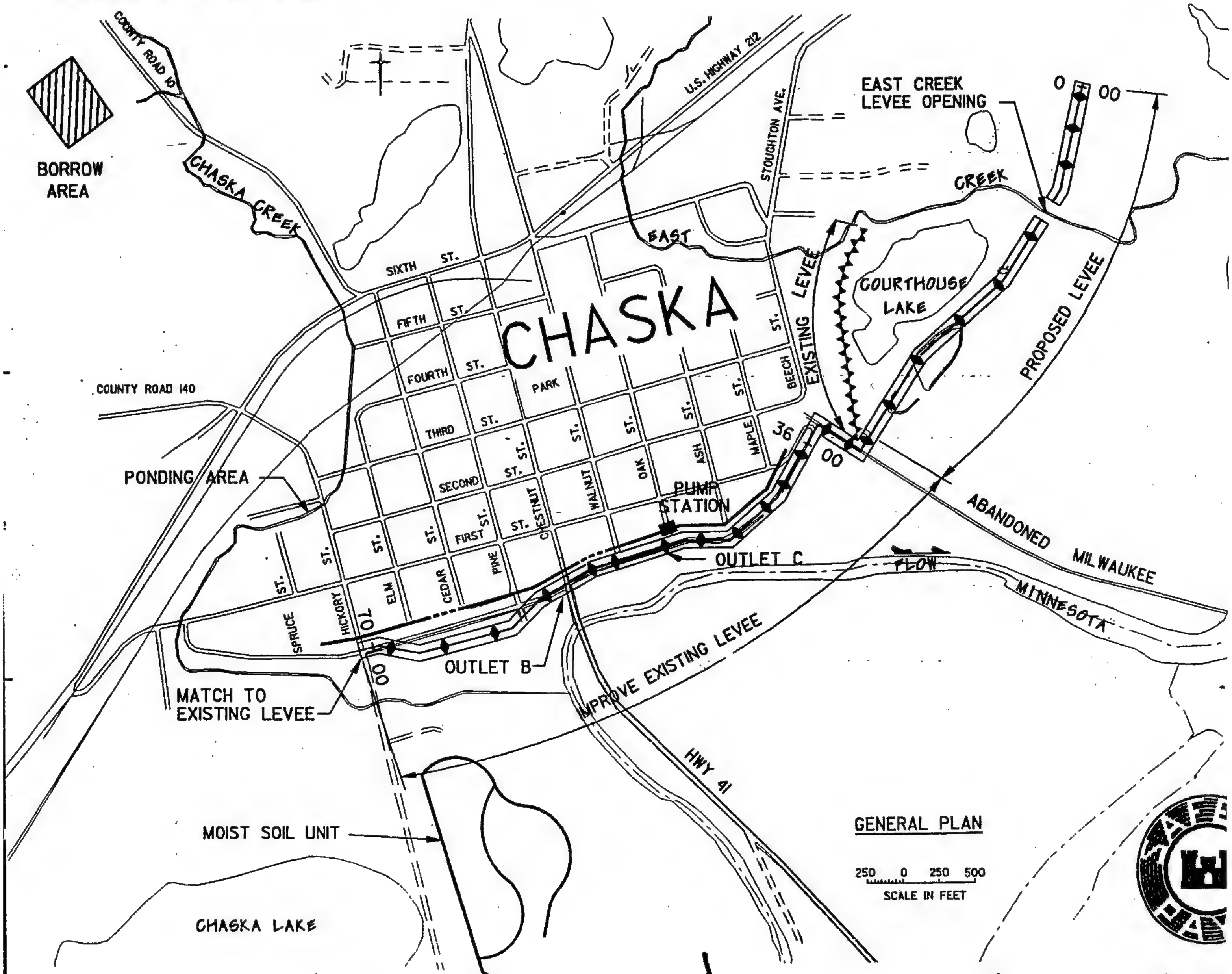
RECOMMENDATION

44. I recommend the approval of the plan for Stage 4, Minnesota River Levees, at Chaska, Minnesota, flood control project as presented in this DM.

ROGER L. BALDWIN
Colonel, Corps of Engineers
District Engineer

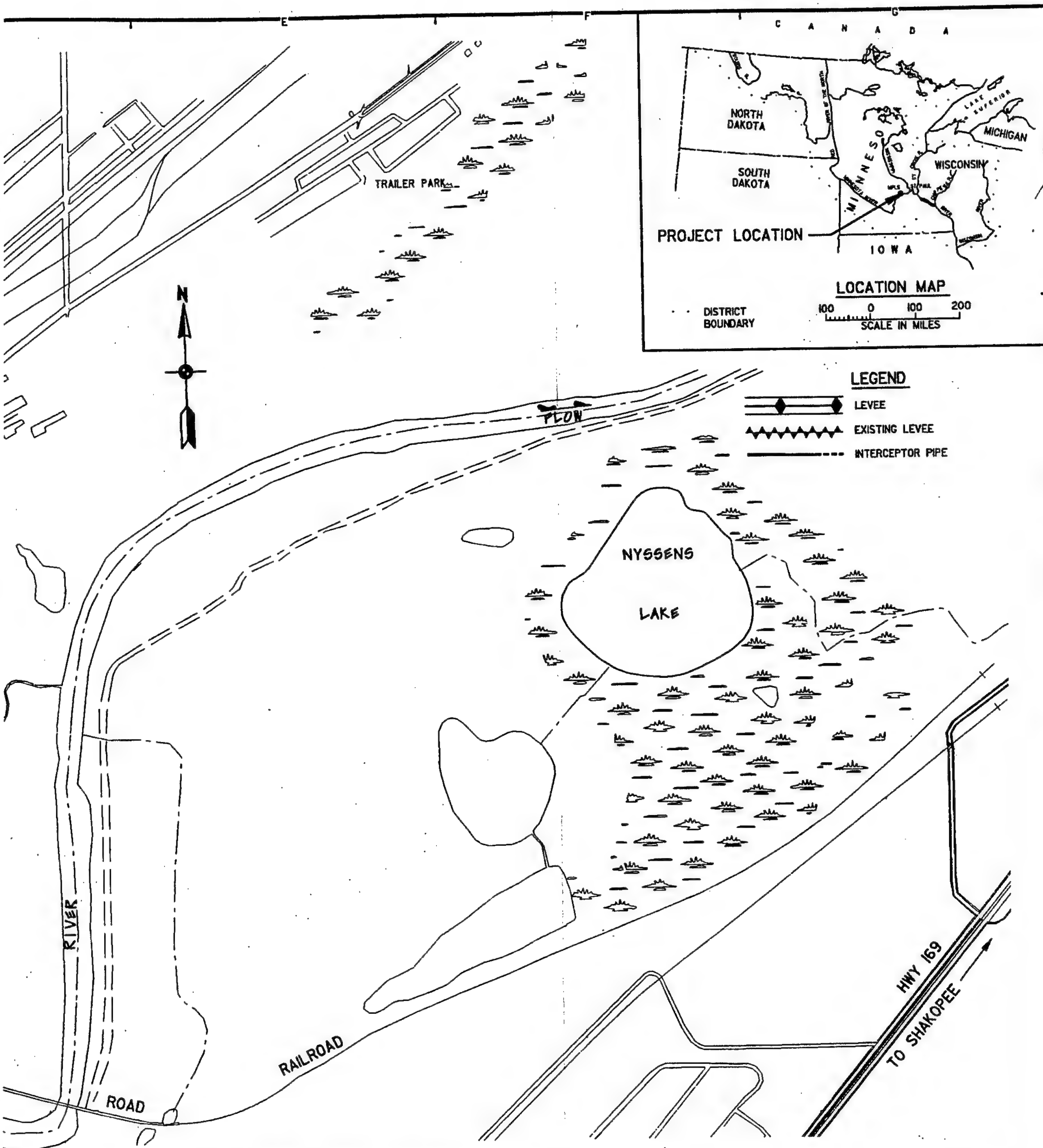
DRAWING INDEX		
DRAWING NO.	SHT.	DESCRIPTION
PROJECT LOCATION		
M34-CH-R-5/200	1	LOCATION MAP, GENERAL PLAN, AND DRAWING SCHEDULE
DRAINAGE AND LEVEES		
M34-CH-R-5/201	2	PLAN AND PROFILE STA. 0+00 TO 10+00
M34-CH-R-5/202	3	PLAN AND PROFILE STA. 10+00 TO 19+50
M34-CH-R-5/203	4	PLAN AND PROFILE STA. 19+50 TO 28+90
M34-CH-R-5/204	5	PLAN AND PROFILE STA. 28+90 TO 36+70
M34-CH-R-5/205	6	PLAN AND PROFILE STA. 36+70 TO 45+50
M34-CH-R-5/206	7	PLAN AND PROFILE STA. 45+50 TO 55+50
M34-CH-R-5/207	8	PLAN AND PROFILE STA. 55+50 TO 66+00
M34-CH-R-5/208	9	PLAN AND PROFILE STA. 66+00 TO 76+50
M34-CH-R-5/209	10	PLAN AND PROFILE STA. 76+50 TO 82+50
M34-CH-R-5/210	11	LEVEE CROSS SECTIONS
M34-CH-R-5/211	12	LEVEE CROSS SECTIONS
M34-CH-R-5/212	13	LEVEE CROSS SECTIONS
M34-CH-R-5/213	14	PROFILE, PEDESTRIAN BRIDGE APPROACH
M34-CH-R-5/214	15	PROFILE, SANITARY OUTFALL PIPE
INTERIOR DRAINAGE		
M34-CH-R-5/215	16	MANHOLES AND INLETS
M34-CH-R-5/216	17	MANHOLES, PLAN AND SECTIONS
M34-CH-R-5/217	18	MANHOLES, PLAN AND SECTIONS
M34-CH-R-5/218	19	INLETS - PLANS, SECTIONS, AND SCHEDULE
M34-CH-R-5/219	20	RELIEF WELLS, SECTIONS AND SCHEDULE
M34-CH-R-5/220	21	OUTLET C, PROFILES
M34-CH-R-5/221	22	OUTLET B, PROFILE

DRAWING INDEX		
DRAWING NO.	SHT.	DESCRIPTION
M34-CH-R-5/222	23	GATEWELL B, PLAN AND SECTIONS
M34-CH-R-5/223	24	GATEWELL C, PLAN AND SECTIONS
PUMPING STATION		
M34-CH-R-5/224	25	SITE DRAWING
M34-CH-R-5/225	26	SITE PLAN AND PERSPECTIVE SKETCHES
M34-CH-R-5/226	27	LAYOUT PLANS
M34-CH-R-5/227	28	LAYOUT SECTIONS
M34-CH-R-5/228	29	LAYOUT SECTIONS & DETAILS
M34-CH-R-5/229	30	3 PUMP CONTROL DIAGRAM
RECREATION		
M34-CH-R-5/230	31	COURTHOUSE LAKE TRAIL



GENERAL PLAN

250 0 250 500
SCALE IN FEET



SIGNATURES AFFIXED BELOW INDICATE OFFICIAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS IN THIS SET, AS INDEXED ON THIS SHEET.

APPROVAL RECOMMENDED BY:

CHIEF ED-D BRANCH

CHIEF ED-GH BRANCH

CHIEF ENGINEERING DIVISION

APPROVED BY:

COL., CORPS OF ENGINEERS

ENGINEER MANAGER

CHIEF SPECS. & TECH. SUPPORT SECTION

CHIEF GENERAL ENGINEERING SECTION

CHIEF STRUCTURAL SECTION

CHIEF MECH/ELEC/ARCH SECTION

CHIEF HYDRAULICS SECTION

CHIEF HYDROLOGY SECTION

CHIEF GEOTECHNICAL DESIGN SECTION

	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

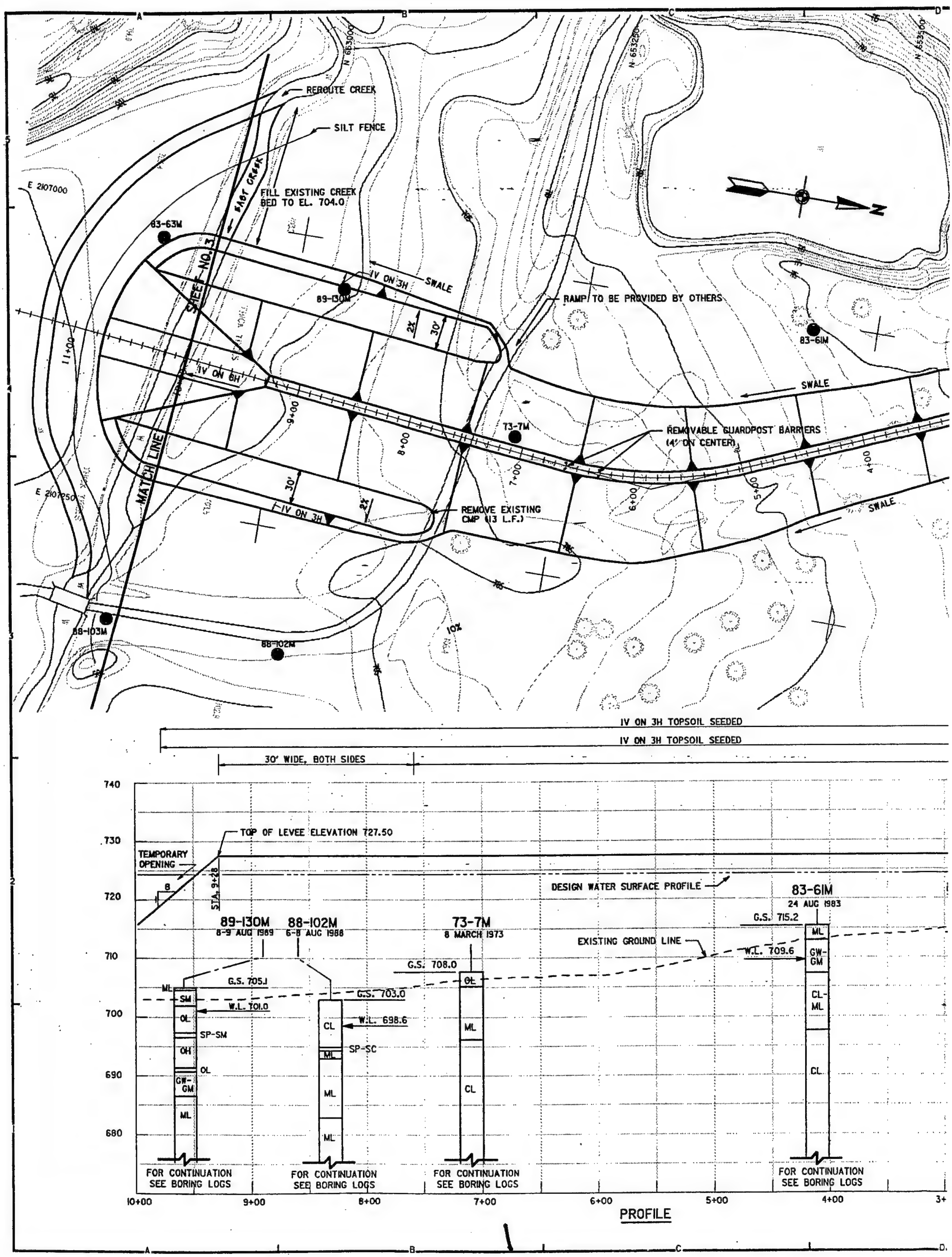
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
DRAINAGE & LEVEE
LOCATION MAP, GENERAL PLAN AND DRAWING INDEX

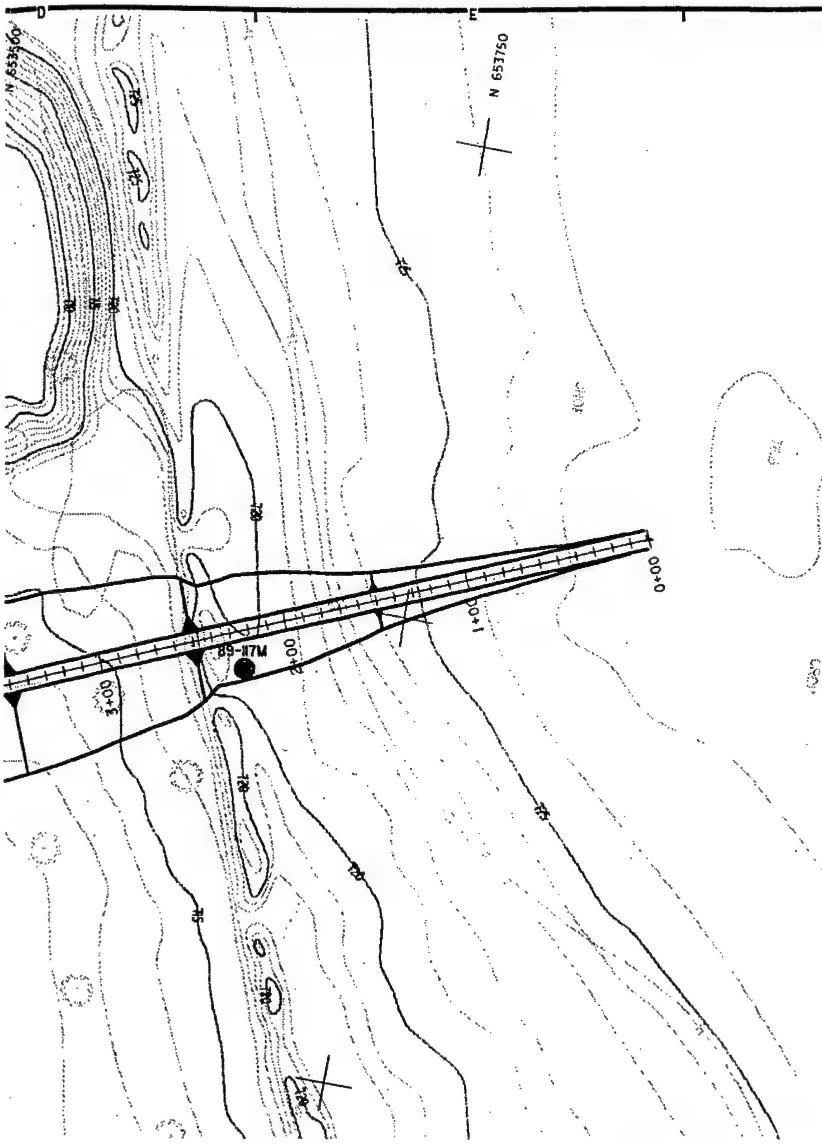
ED-D	DESIGNED:	R.J.M.
ED-D	CHECKED:	J.J.G.
ED-D	DRAWN:	R.J.M.-T.J.
ED-GH	DESIGNED:	W.J.M.-J.R.C.
ED-GH	CHECKED:	
	DATE:	MARCH 1991

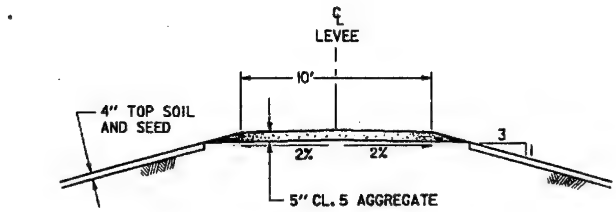
CAD FILE NAME: MNICPOOO.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/200
SHT 1 OF 31

2

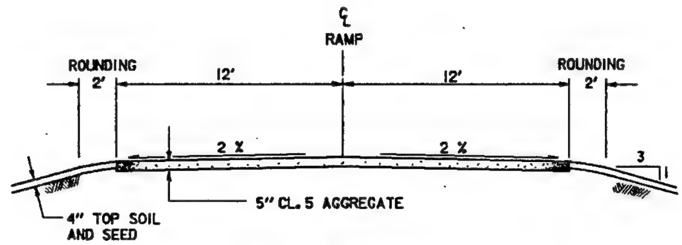


REROUTE CREEK
SILT FENCE
FILL EXISTING CREEK BED TO EL. 704.0
EAST CREEK
SHEET NO. 3
MATCH LINE
83-63M
89-130M
1V ON 3H
SWALE
RAMP TO BE PROVIDED BY OTHERS
83-61M
1V ON 6H
73-7M
REMOVABLE GUARDPOST BARRIERS (4' ON CENTER)
REMOVE EXISTING CMP (13 L.F.)
88-103M
88-102M
10%
E 2107000
E 2107250
N 653000
N 653250
N 653500
11+00
9+00
8+00
7+00
6+00
5+00
4+00
1V ON 3H TOPSOIL SEEDED
1V ON 3H TOPSOIL SEEDED
30' WIDE, BOTH SIDES
TOP OF LEVEE ELEVATION 727.50
TEMPORARY OPENING
STA. 9+28
DESIGN WATER SURFACE PROFILE
EXISTING GROUND LINE
89-130M 8-9 AUG 1989
88-102M 6-8 AUG 1988
73-7M 8 MARCH 1973
83-61M 24 AUG 1983
G.S. 705.1
G.S. 703.0
G.S. 708.0
G.S. 715.2
W.L. 701.0
W.L. 698.6
W.L. 709.6
ML
SM
OL
SP-SM
OH
GW-GM
SP-SC
CL
CL-ML
FOR CONTINUATION SEE BORING LOGS
740
730
720
710
700
690
680
10+00
3+
PROFILE



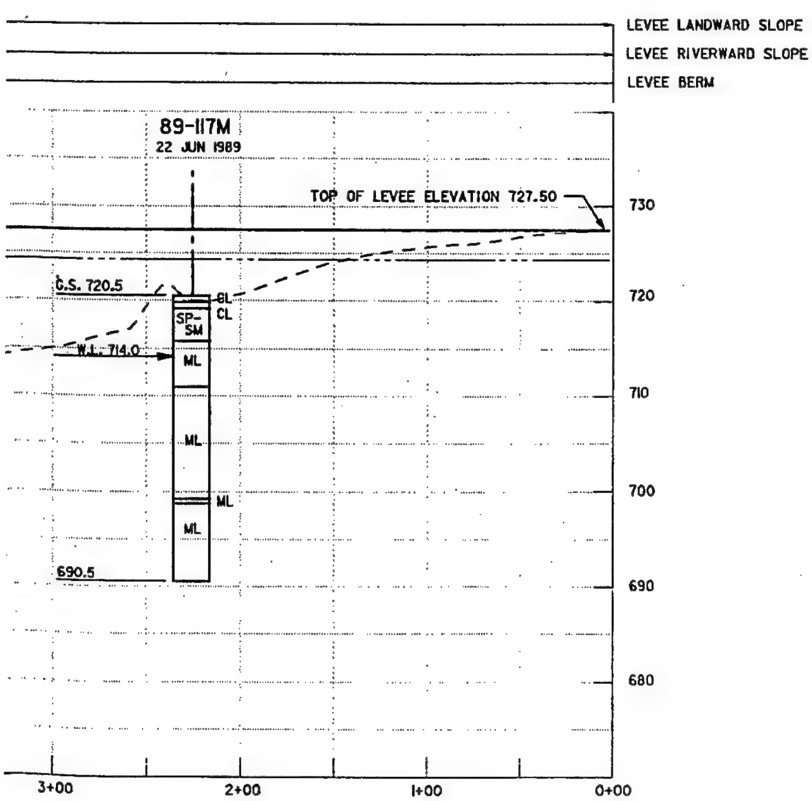


TYPICAL SECTION
STA. 0+00 TO STA. 28+50
TRAIL ON TOP OF LEVEE
NO SCALE



TYPICAL SECTION
TWO LANE RAMP

PLAN VIEW
50 0 50 100
SCALE IN FEET



NOTES:
1. ELEVATIONS REFER TO M.S.L. (1929 ADJ.)
2. COORDINATES AND GRID FOR PROJECT ARE LAMBERT GRID, MINNESOTA SOUTH ZONE.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

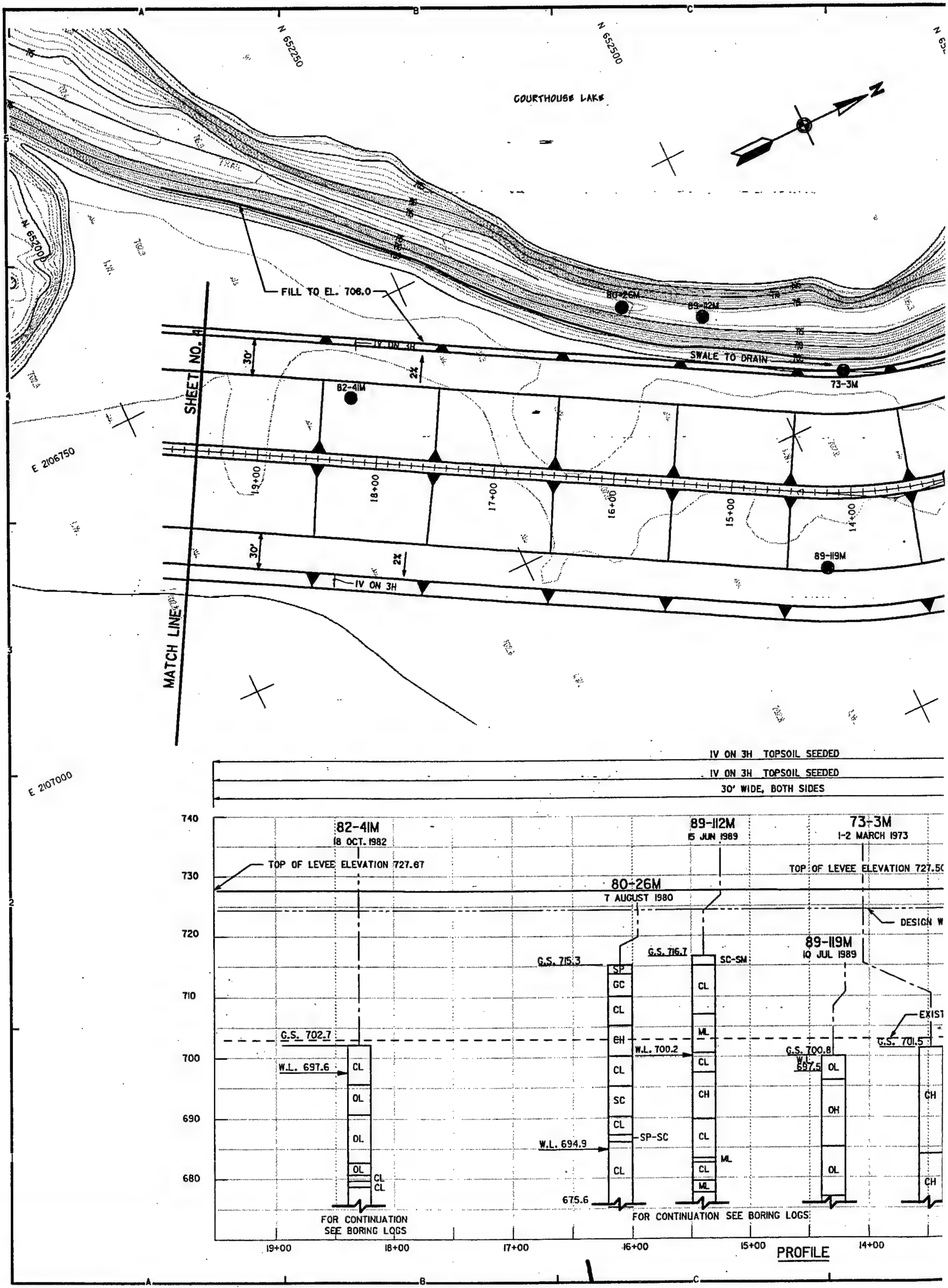
AE APPROVING OFFICIAL:

ED-D DESIGNED:	R.J.M.
CHECKED:	J.J.C.
DRAWN:	T.J. R.J.M.
ED-GH DESIGNED:	J.R.C. J.W.M.
CHECKED:	
DATE:	MARCH 1991

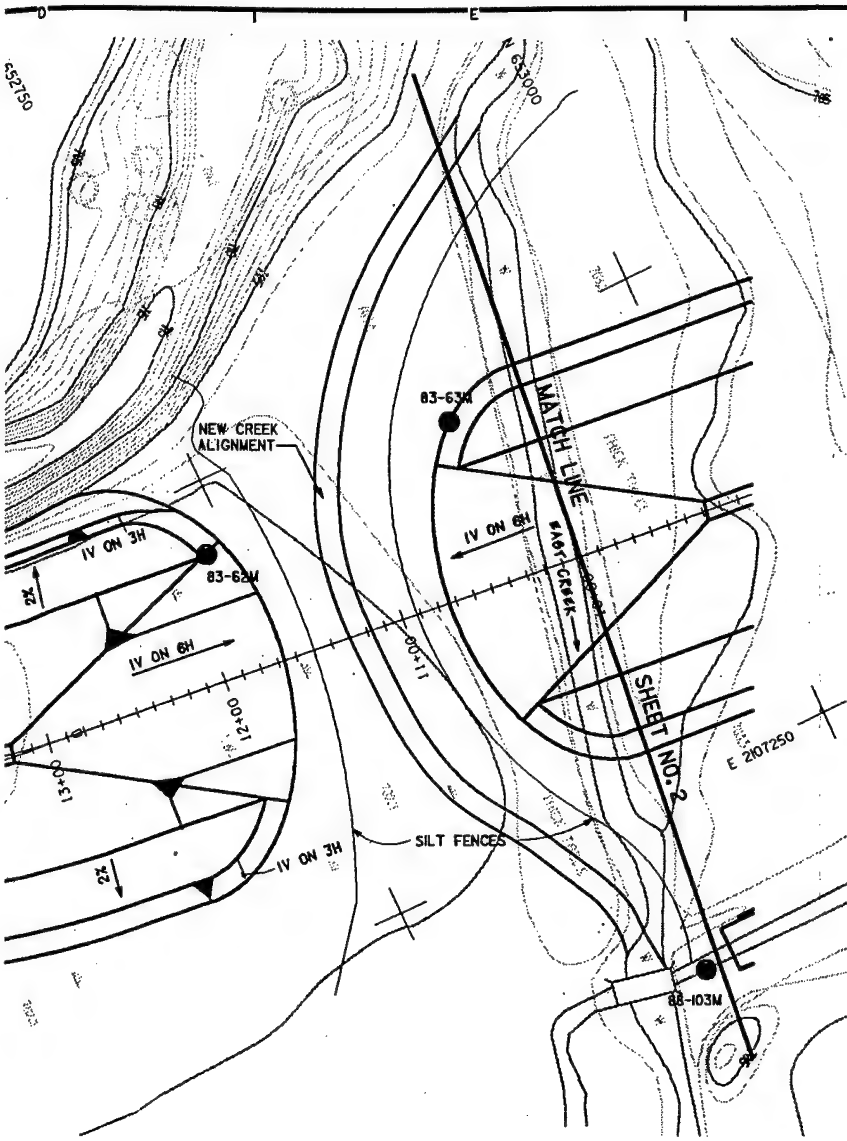
DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
DRAINAGE & LEVEES
PLAN & PROFILE
STA. 0+00 TO 10+00

CAD FILE NAME: MNIOPOOI.DGN
SPEC NO: DACW37-90-B-000?
DRAWING NUMBER: M34-CH-R-51/201
SHT 2 OF 31

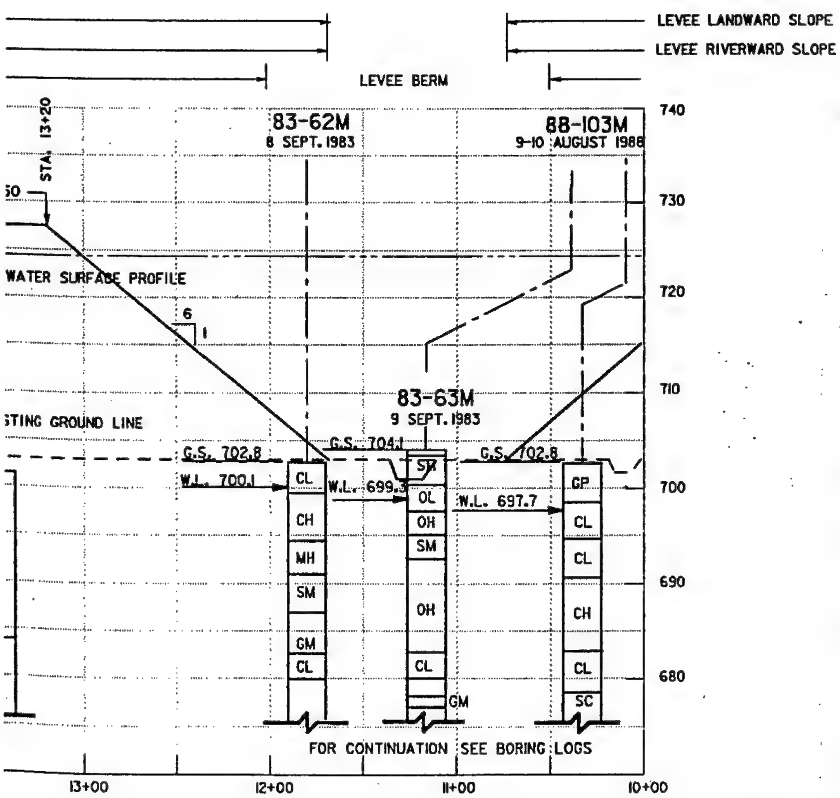
2



N 652250
N 652500
COURTHOUSE LAKE
N 652000
FILL TO EL. 706.0
80-26M
89-112M
1V ON 3H
30'
2%
SWALE TO DRAIN
73-3M
82-41M
SHEET NO. 4
MATCH LINE
E 2106750
19+00
18+00
17+00
16+00
15+00
14+00
89-119M
1V ON 3H
E 2107000
1V ON 3H TOPSOIL SEEDED
1V ON 3H TOPSOIL SEEDED
30' WIDE, BOTH SIDES
740
730
720
710
700
690
680
82-41M
18 OCT. 1982
TOP OF LEVEE ELEVATION 727.67
89-112M
15 JUN 1989
73-3M
1-2 MARCH 1973
TOP OF LEVEE ELEVATION 727.50
80-26M
7 AUGUST 1980
DESIGN W
89-119M
10 JUL 1989
G.S. 715.3
G.S. 716.7
SP
GC
CL
CH
SC
SP-SC
SC-SM
ML
OL
OH
G.S. 702.7
W.L. 697.6
W.L. 700.2
G.S. 700.8
W.L. 697.5
G.S. 701.5
EXIST
W.L. 694.9
675.6
FOR CONTINUATION SEE BORING LOGS
FOR CONTINUATION SEE BORING LOGS
PROFILE



PLAN VIEW



NOTES:

1. ELEVATIONS REFER TO M.S.L. (1929 ADJ.)
2. COORDINATES AND GRID FOR PROJECT ARE LAMBERT GRID, MINNESOTA SOUTH ZONE.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

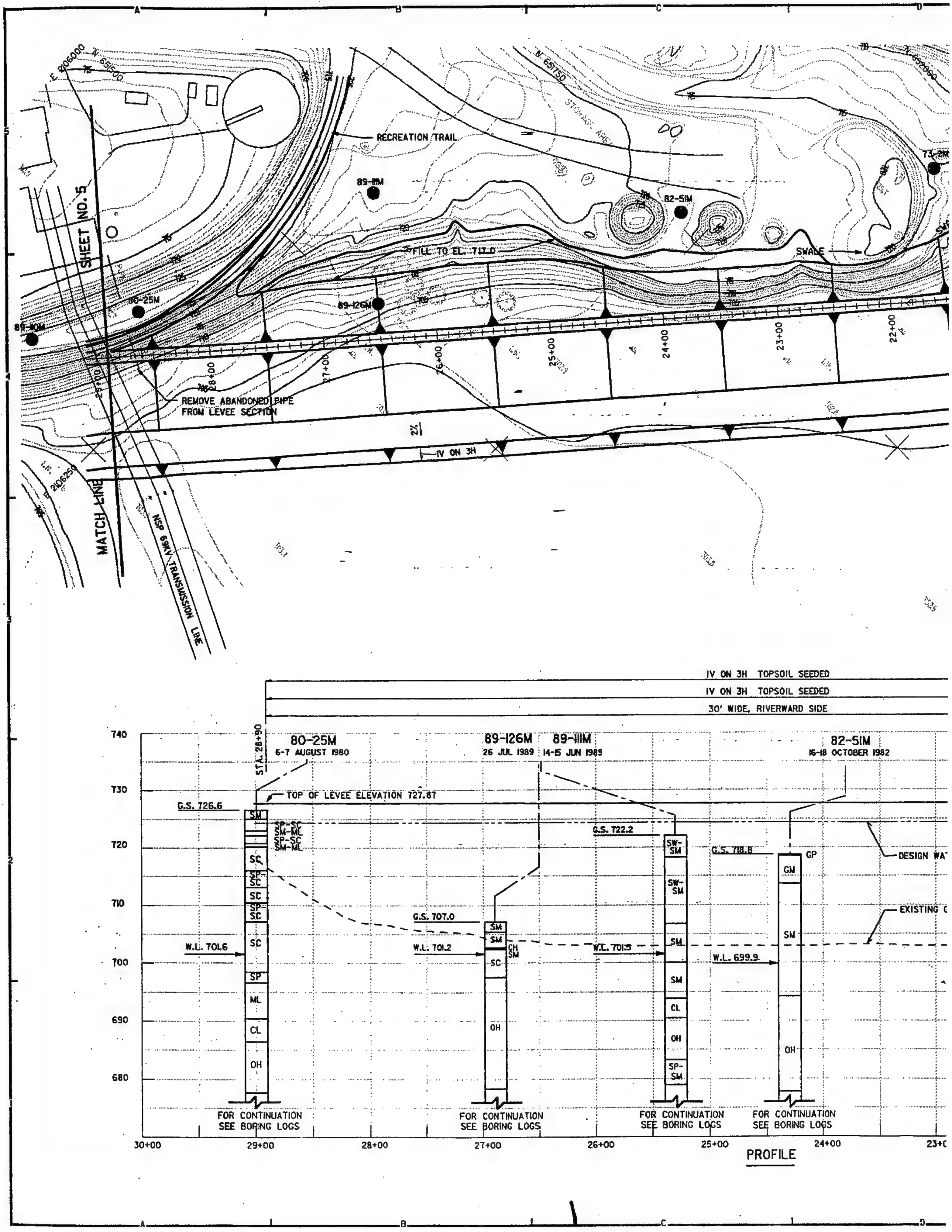
DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA

DRAINAGE & LEVEES
PLAN & PROFILE
STA. 10+00 TO 19+50

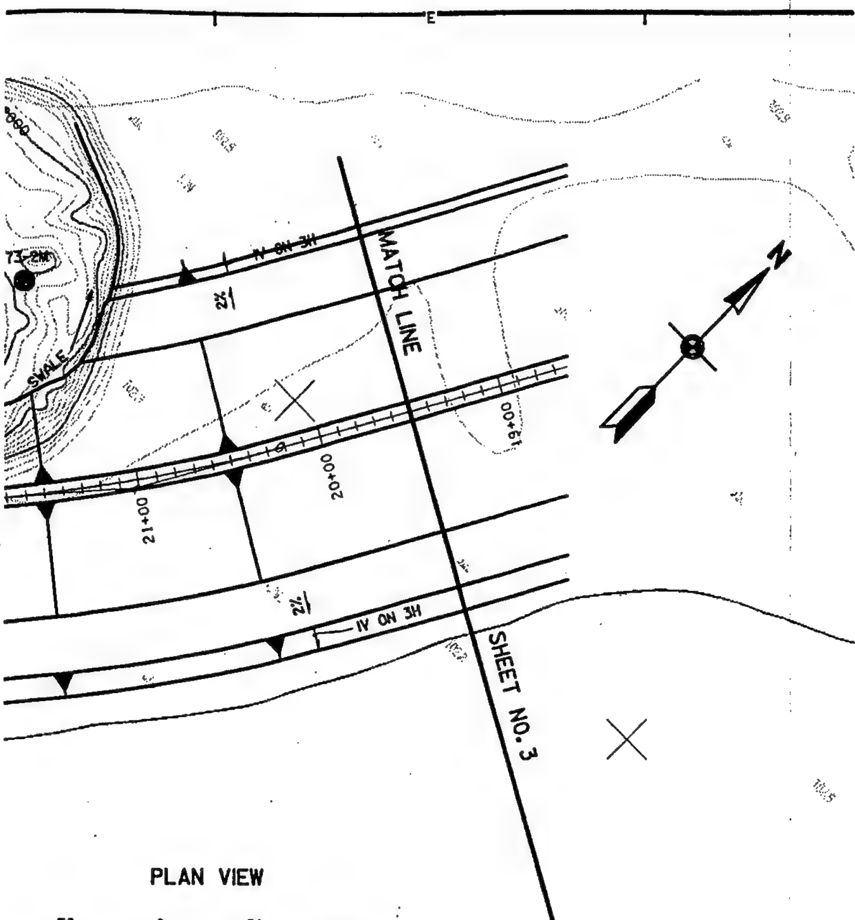
ED-D	DESIGNED:	R.J.M.
	CHECKED:	J.J.G.
	DRAWN:	T.J. R.J.M.
ED-GH	DESIGNED:	J.R.C.
	CHECKED:	
DATE:	MAR 1991	

CAD FILE NAME: MNIOP002.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/202
SHT 3 OF 31

2

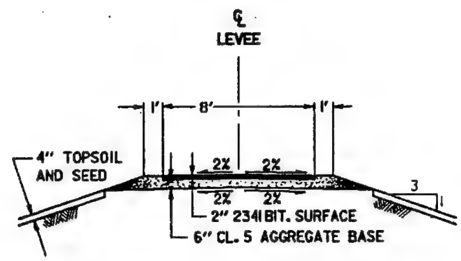


RECREATION TRAIL
89-111M
82-51M
73-2M
FILL TO EL. 717.0
SWALE
SHEET NO. 5
80-25M
89-126M
89-110M
REMOVE ABANDONED PIPE
FROM LEVEE SECTION
IV ON 3H
MATCH LINE
NSP 69KV TRANSMISSION LINE
IV ON 3H TOPSOIL SEEDED
IV ON 3H TOPSOIL SEEDED
30' WIDE, RIVERWARD SIDE
STA. 28+90
80-25M
6-7 AUGUST 1980
89-126M
26 JUL 1989
89-111M
14-15 JUN 1989
82-51M
16-18 OCTOBER 1982
TOP OF LEVEE ELEVATION 727.87
G.S. 726.6
G.S. 722.2
G.S. 718.8
G.S. 707.0
W.L. 701.6
W.L. 701.2
W.L. 701.5
W.L. 699.9
DESIGN WA
EXISTING G
FOR CONTINUATION
SEE BORING LOGS
PROFILE



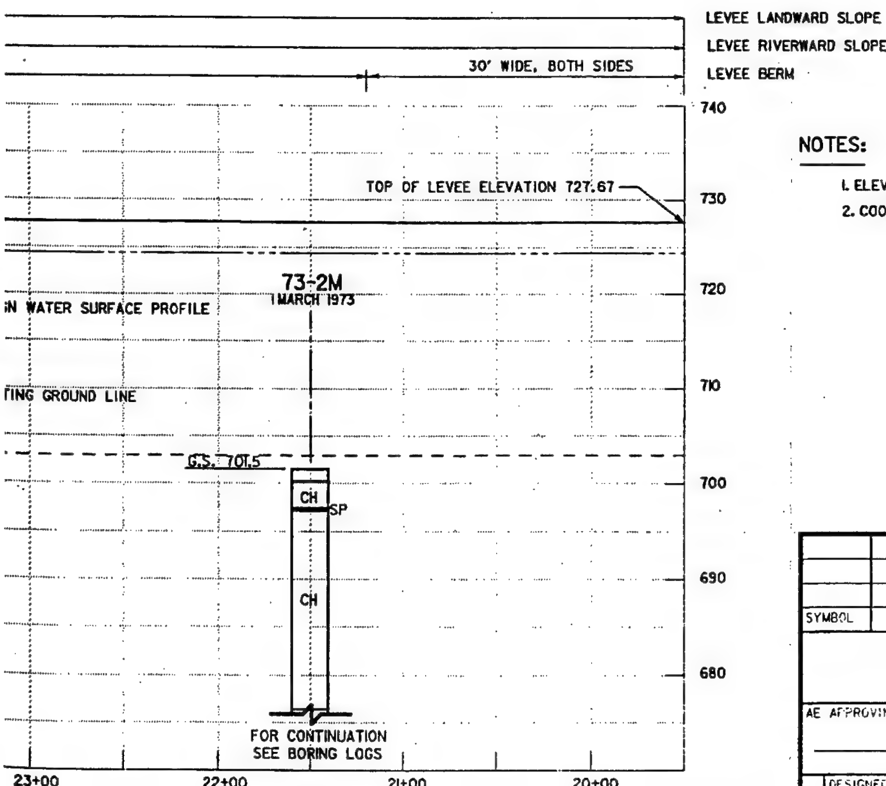
PLAN VIEW

50 0 50 100
SCALE IN FEET



TYPICAL SECTION

STA. 28+50 TO STA. 71+17
TRAIL ON TOP OF LEVEE
NO SCALE



NOTES:

1. ELEVATIONS REFER TO M.S.L. (1929 ADJ.)
2. COORDINATES AND GRID FOR PROJECT ARE LAMBERT GRID, MINNESOTA SOUTH ZONE.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

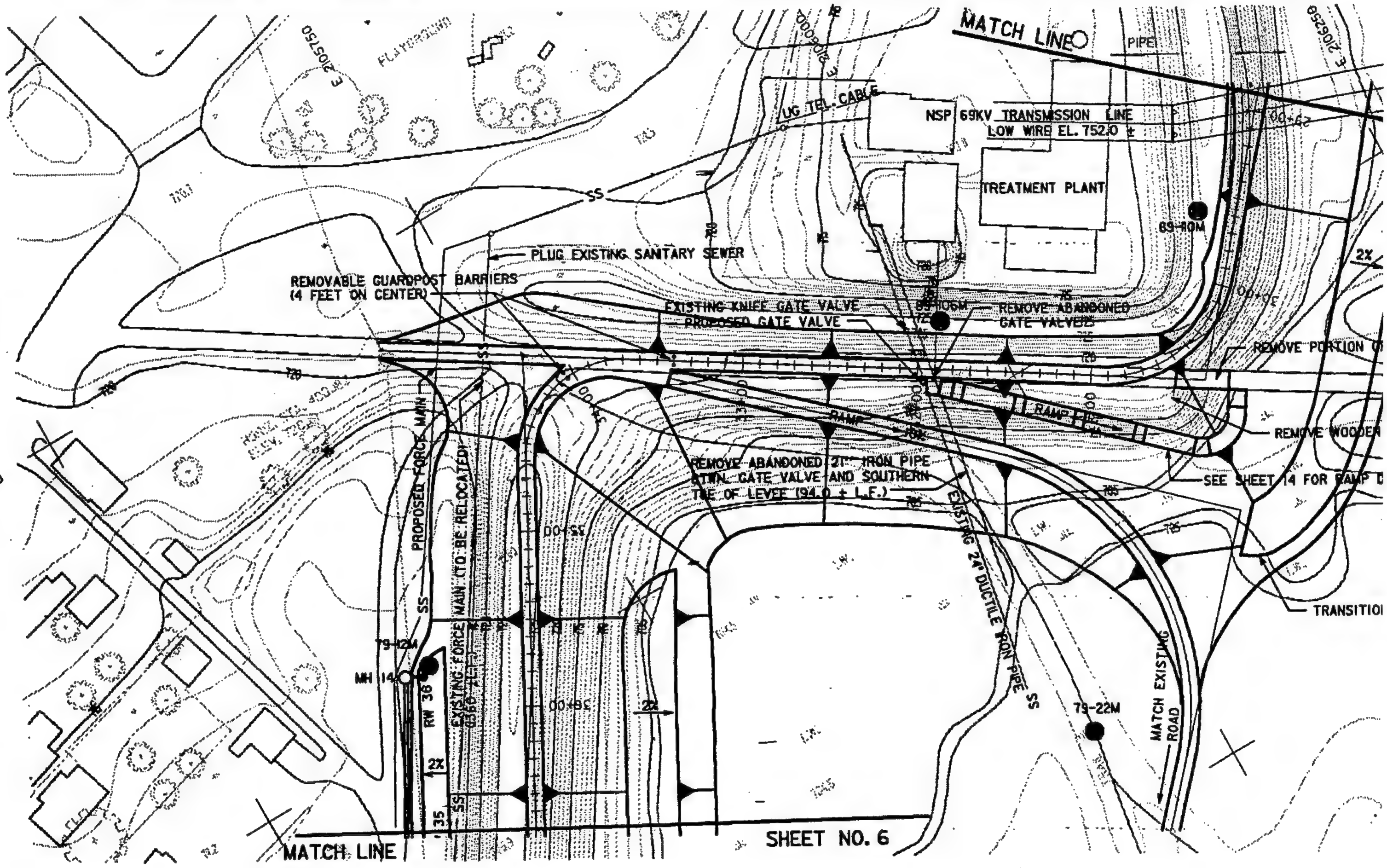
DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA

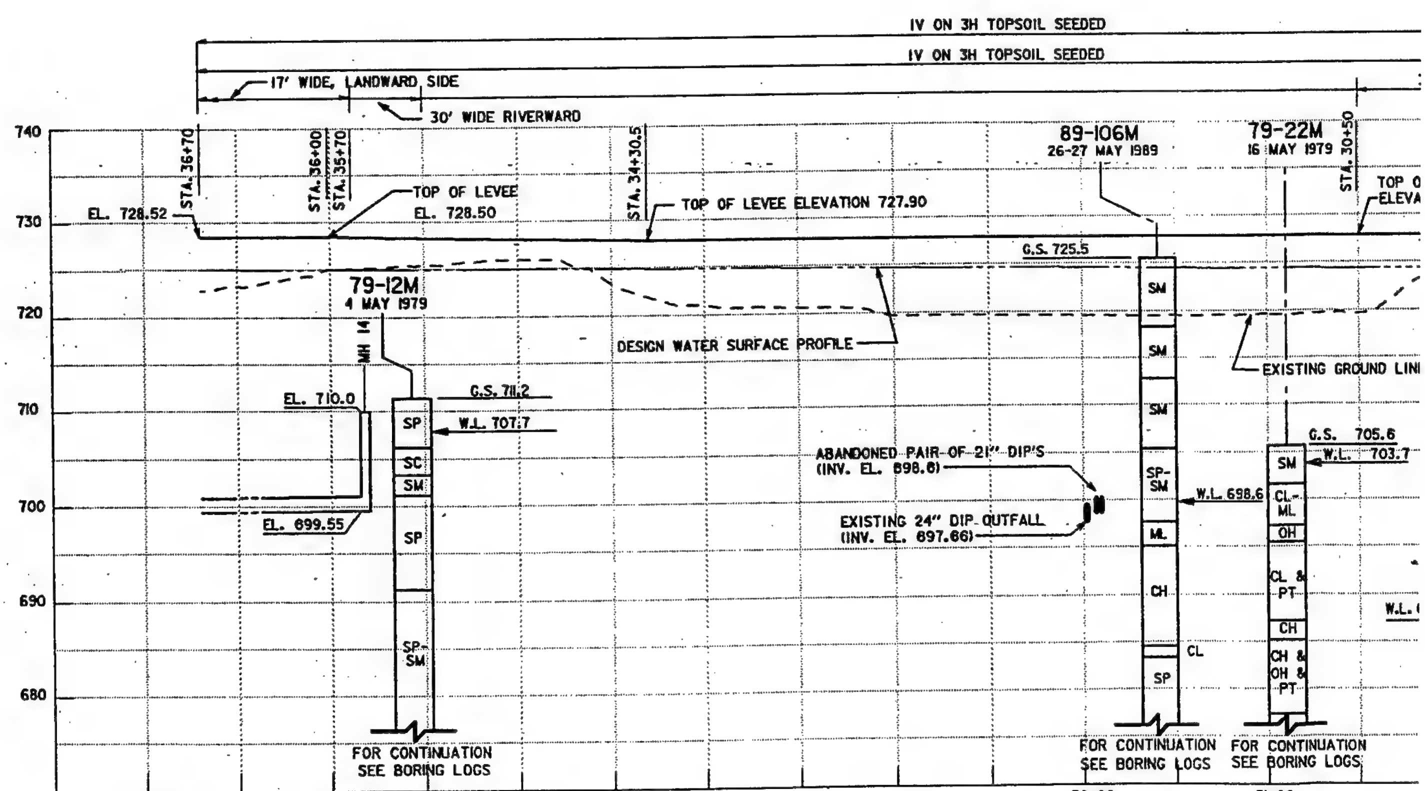
DRAINAGE & LEVEES
PLAN & PROFILE
STA. 19+50 TO 28+90

ED-D	DESIGNED:	R.J.M.
	CHECKED:	J.J.G.
	DRAWN:	T.J. - R.J.M.
ED-GH	DESIGNED:	J.R.C.
	CHECKED:	
DATE:	MARCH 1991	

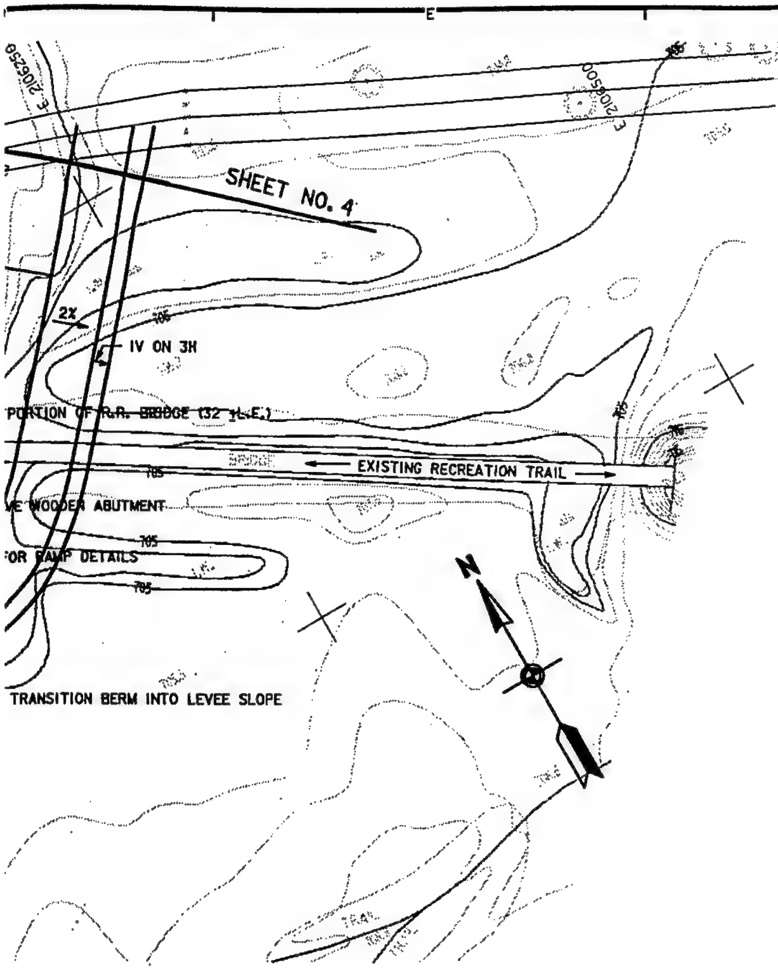
CAD FILE NAME: MNIOP003.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/203
SHT 4 OF 3

2


MATCH LINE
NSP 69KV TRANSMISSION LINE
LOW WIRE EL. 752.0 ±
UG TEL. CABLE
TREATMENT PLANT
PLAYGROUND
89-40M
PLUG EXISTING SANITARY SEWER
REMOVABLE GUARDPOST BARRIERS
(4 FEET ON CENTER)
EXISTING KNIFE GATE VALVE
PROPOSED GATE VALVE
REMOVE ABANDONED GATE VALVES
REMOVE PORTION OF
REMOVE WOODEN
SEE SHEET 14 FOR RAMP D
RAMP
REMOVE ABANDONED 21" IRON PIPE
BTWN. GATE VALVE AND SOUTHERN
TOE OF LEVEE (94.0 ± L.F.)
EXISTING 24" DUCTILE IRON PIPE
PROPOSED FORCE MAIN
EXISTING FORCE MAIN (TO BE RELOCATED)
TRANSITION
79-12M
MH 14
RW 38
79-22M
MATCH EXISTING ROAD
2%
SS
N 651500
E 2105500
E 2105750
E 2106250
MATCH LINE
SHEET NO. 6

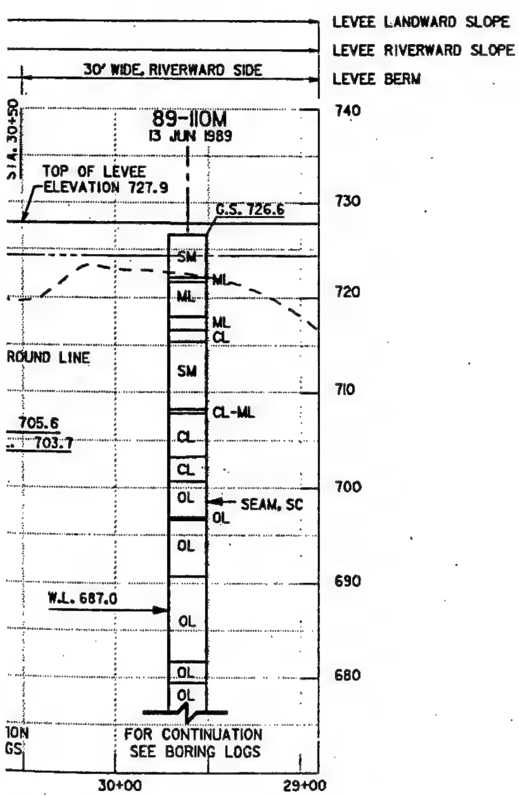

IV ON 3H TOPSOIL SEEDED
IV ON 3H TOPSOIL SEEDED
17' WIDE, LANDWARD SIDE
30' WIDE RIVERWARD
740
730
720
710
700
690
680
STA. 36+70
STA. 36+00
STA. 35+70
STA. 34+30.5
STA. 30+50
EL. 728.52
TOP OF LEVEE
EL. 728.50
TOP OF LEVEE ELEVATION 727.90
TOP OF LEVEE ELEVATION
89-106M
26-27 MAY 1989
79-22M
16 MAY 1979
G.S. 725.5
79-12M
4 MAY 1979
MH 14
DESIGN WATER SURFACE PROFILE
EXISTING GROUND LINE
EL. 710.0
G.S. 711.2
W.L. 707.7
EL. 699.55
ABANDONED PAIR OF 21" DIP'S
(INV. EL. 698.6)
EXISTING 24" DIP OUTFALL
(INV. EL. 697.66)
W.L. 698.6
G.S. 705.6
W.L. 703.7
SP
SC
SM
SP
SP-SM
SM
SM
SM
SP-SM
ML
CH
CL
SP
SM
CL-ML
OH
CL & PT
CH
CH & OH & PT
FOR CONTINUATION SEE BORING LOGS
FOR CONTINUATION SEE BORING LOGS
FOR CONTINUATION SEE BORING LOGS
37+00
36+00
35+00
34+00
33+00
32+00
31+00

PROFILE



PLAN VIEW

50 0 50 100
SCALE IN FEET



NOTES:

1. ELEVATIONS REFER TO M.S.L. (1929 ADJ.)
2. COORDINATES AND GRID FOR PROJECT ARE LAMBERT GRID, MINNESOTA SOUTH ZONE.
3. GUARDRAIL IS TO BE INSTALLED FOR RAMP IN ACCORDANCE WITH THE UNIFORM FEDERAL ACCESSIBILITY STANDARDS (FED-STD-795)

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

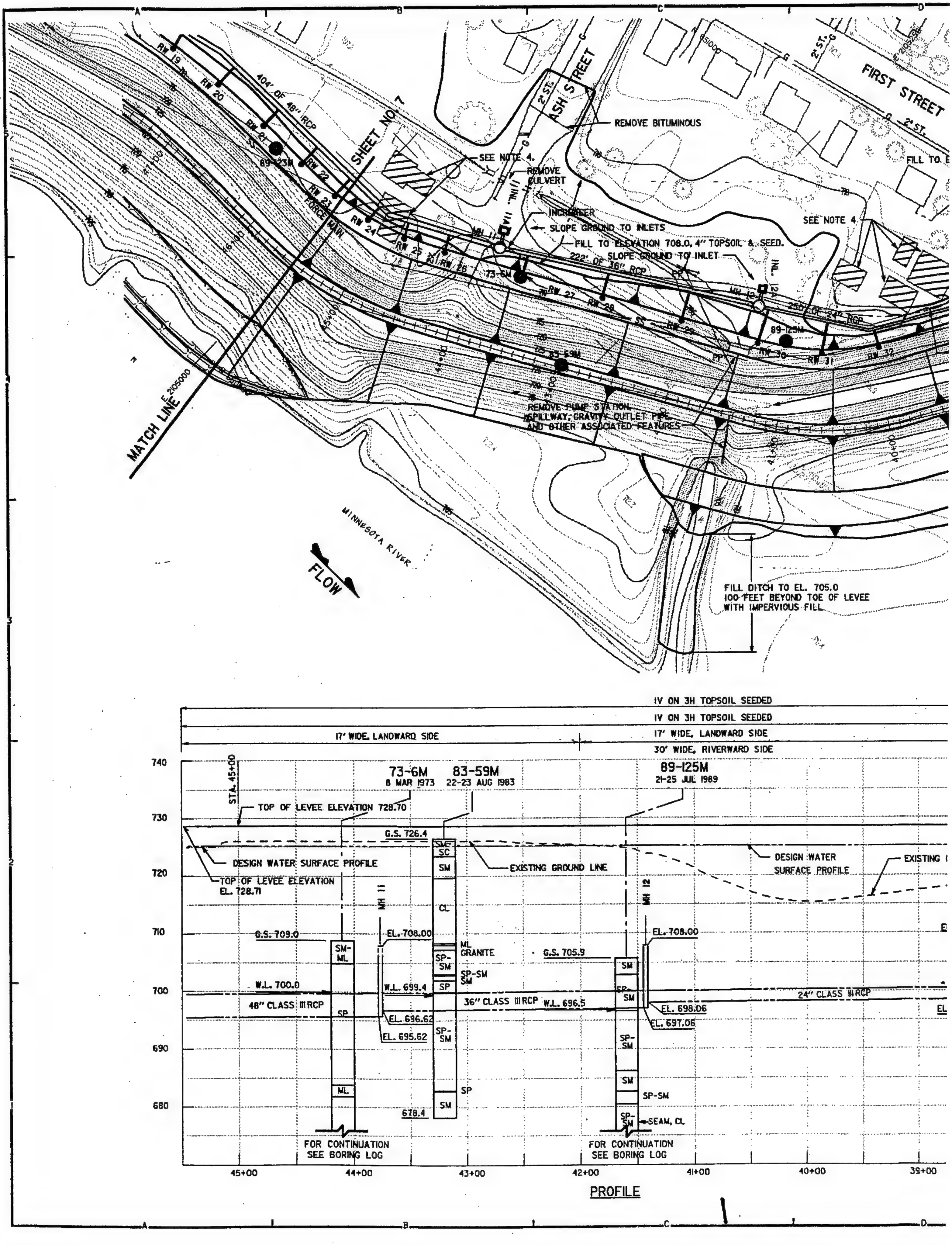
DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
DRAINAGE & LEVEES
PLAN & PROFILE
STA. 28+90 TO 36+70

ED-D	DESIGNED:	R.J.M.
	CHECKED:	J.J.G.
	DRAWN:	T.J. - R.J.M.
ED-GH	DESIGNED:	W.J.M.-J.R.C.
	CHECKED:	

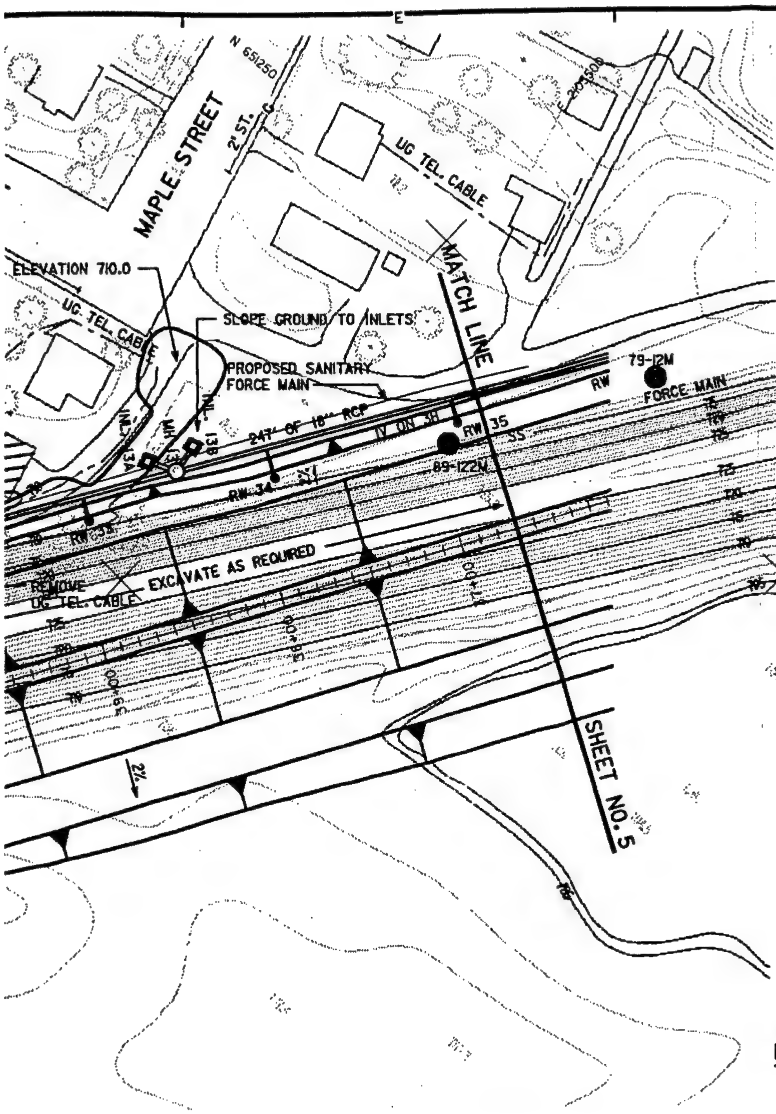
DATE: MARCH 1991

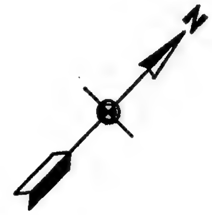
CAD FILE NAME: MNIOP004.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/204
SHT 5 OF 31

2



FIRST STREET
ASH STREET
2' ST.
SHEET NO. 7
MATCH LINE
E 2105000
404' OF 48" RCP
FORCE MAIN
REMOVE BITUMINOUS
SEE NOTE 4.
REMOVE CULVERT
INCINERATOR
SLOPE GROUND TO INLETS
FILL TO ELEVATION 708.0, 4" TOPSOIL & SEED.
SLOPE GROUND TO INLET
222' OF 36" RCP
250' OF 24" RCP
FILL TO E
SEE NOTE 4
89-123M
73-6M
83-59M
89-125M
MH 11
MH 12
INL. 11A
INL. 12A
RW 19
RW 20
RW 21
RW 22
RW 23
RW 24
RW 25
RW 26
RW 27
RW 28
RW 29
RW 30
RW 31
RW 32
REMOVE PUMP STATION, SPILLWAY, GRAVITY OUTLET PIPE AND OTHER ASSOCIATED FEATURES
MINNESOTA RIVER
FLOW
FILL DITCH TO EL. 705.0
100 FEET BEYOND TOE OF LEVEE
WITH IMPERVIOUS FILL
IV ON 3H TOPSOIL SEEDED
IV ON 3H TOPSOIL SEEDED
17' WIDE, LANDWARD SIDE
17' WIDE, LANDWARD SIDE
30' WIDE, RIVERWARD SIDE
STA. 45+00
TOP OF LEVEE ELEVATION 728.70
73-6M
8 MAR 1973
83-59M
22-23 AUG 1983
89-125M
21-25 JUL 1989
G.S. 726.4
DESIGN WATER SURFACE PROFILE
EXISTING GROUND LINE
DESIGN WATER SURFACE PROFILE
EXISTING
TOP OF LEVEE ELEVATION
EL. 728.71
G.S. 709.0
EL. 708.00
EL. 708.00
G.S. 705.3
W.L. 700.0
W.L. 699.4
W.L. 696.5
48" CLASS III RCP
36" CLASS III RCP
24" CLASS III RCP
EL. 696.62
EL. 695.62
EL. 698.06
EL. 697.06
SM-ML
SP
ML
SM
SC
CL
GRANITE
SP-SM
SEAM, CL
678.4
FOR CONTINUATION SEE BORING LOG
FOR CONTINUATION SEE BORING LOG
740
730
720
710
700
690
680
45+00
44+00
43+00
42+00
41+00
40+00
39+00
PROFILE



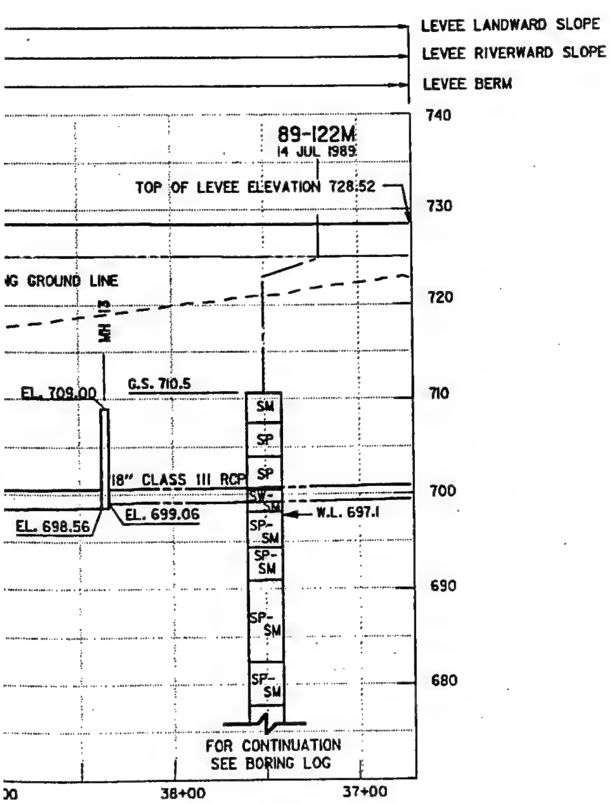


PLAN VIEW

50 0 50 100
SCALE IN FEET

NOTES:

1. ELEVATIONS REFER TO M.S.L. (1929 ADJ.).
2. COORDINATES AND GRID FOR PROJECT ARE LAMBERT GRID, MINNESOTA SOUTH ZONE.
3. FOR WELL SPACING & DEPTH SEE SHEET 20.
4. BUILDINGS TO BE REMOVED BY OTHERS, CONTRACTOR SHALL REMOVE SLAB AND FOUNDATION.



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

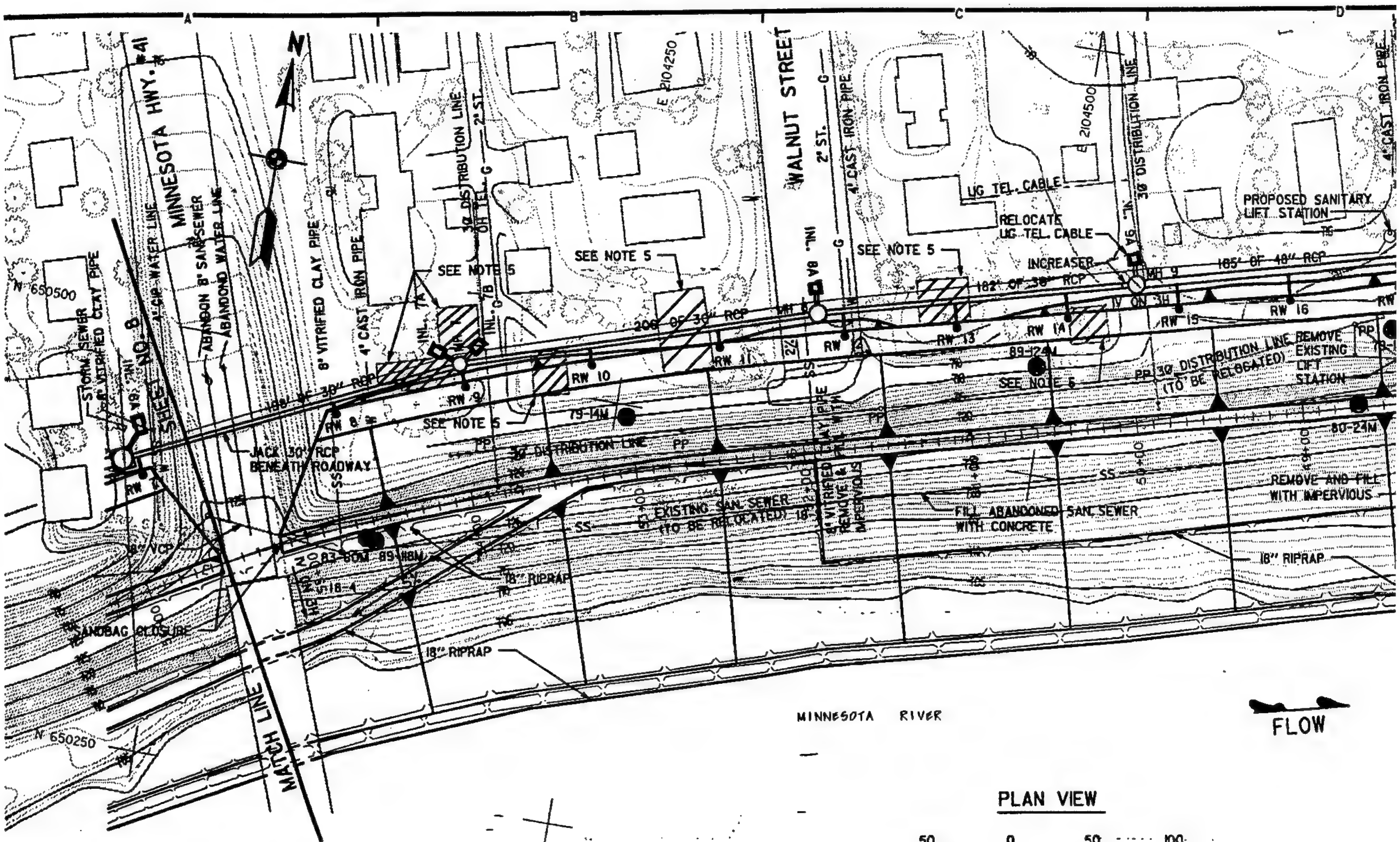
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL – MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
DRAINAGE & LEVEES
PLAN & PROFILE
STA. 36+70 TO 45+50

ED-D	DESIGNED:	R.J.M.
ED-D	CHECKED:	J.J.G.
ED-D	DRAWN:	T.J. - R.J.M.
ED-GH	DESIGNED:	W.J.M.-J.R.C.
ED-GH	CHECKED:	
	DATE: MARCH 1991	

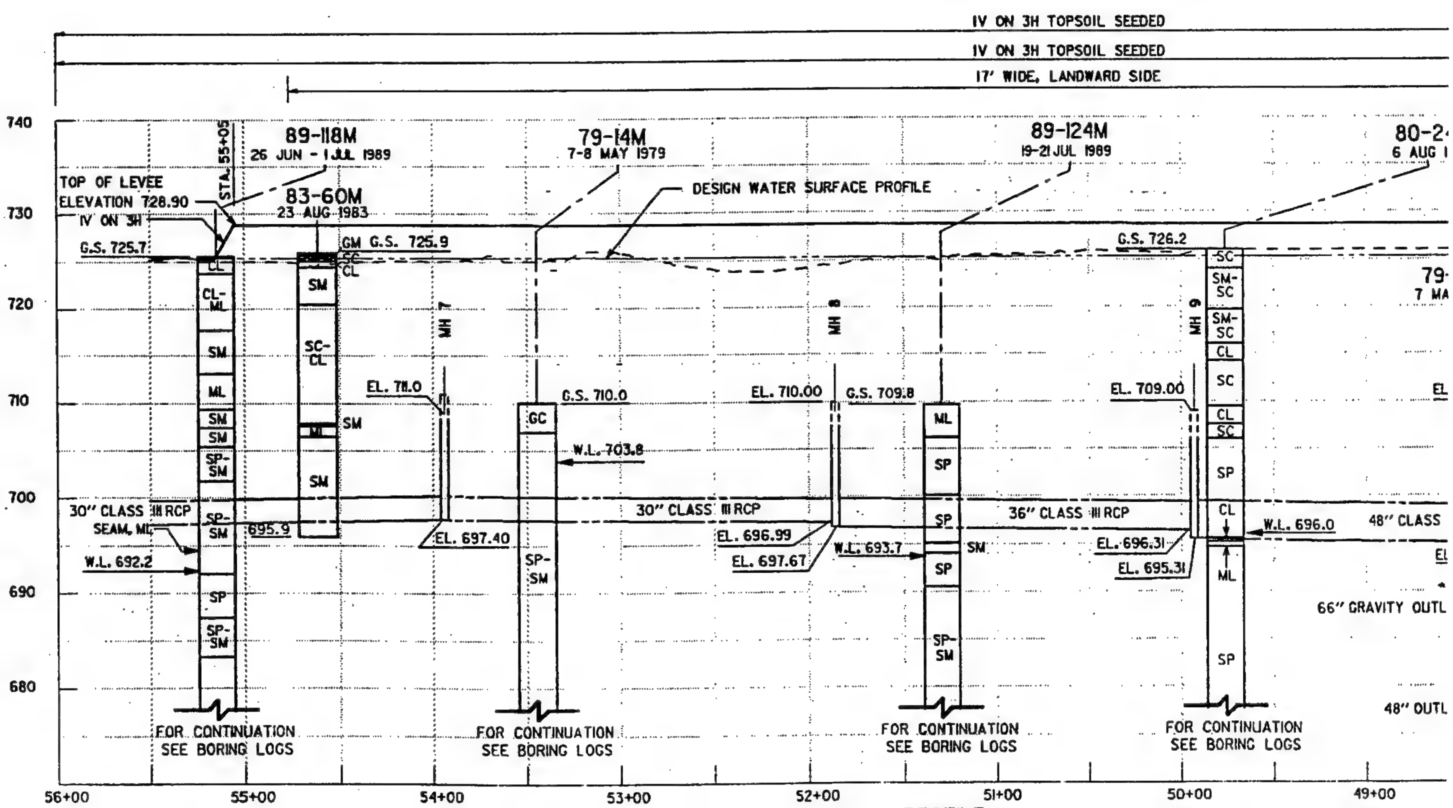
CAD FILE NAME: MNIOP005.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/205
SHT 6 OF

2

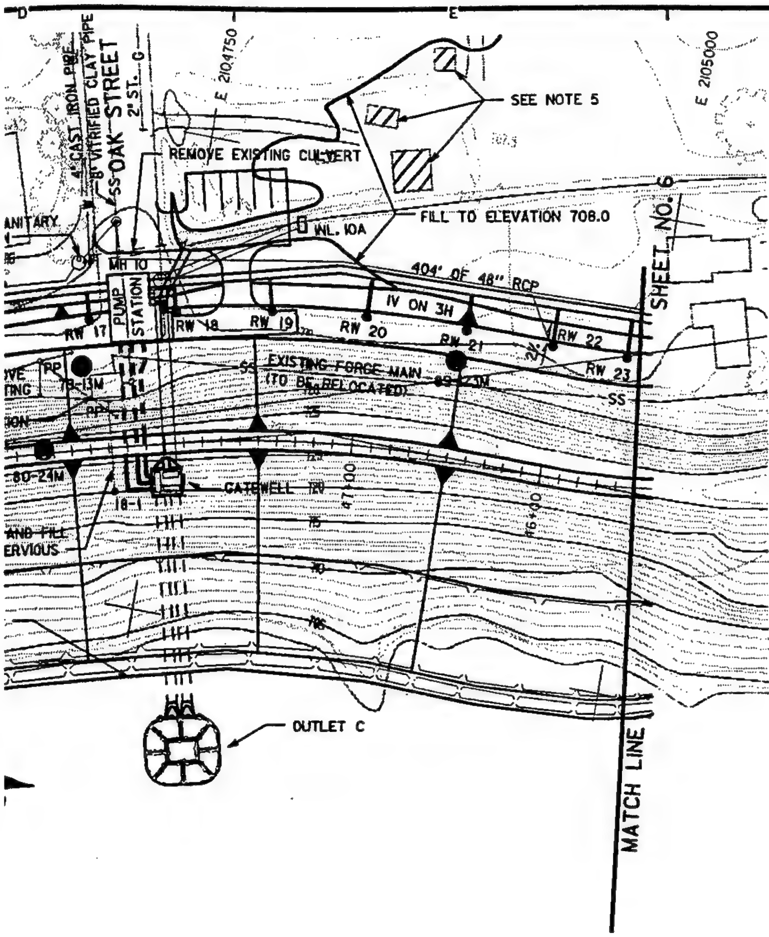


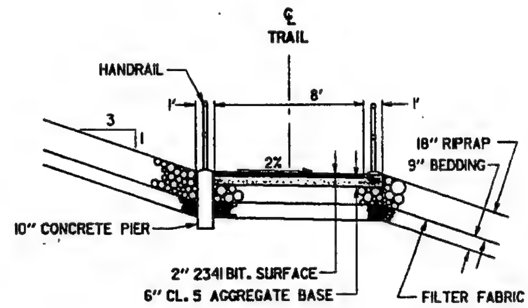
PLAN VIEW

SCALE IN FEET



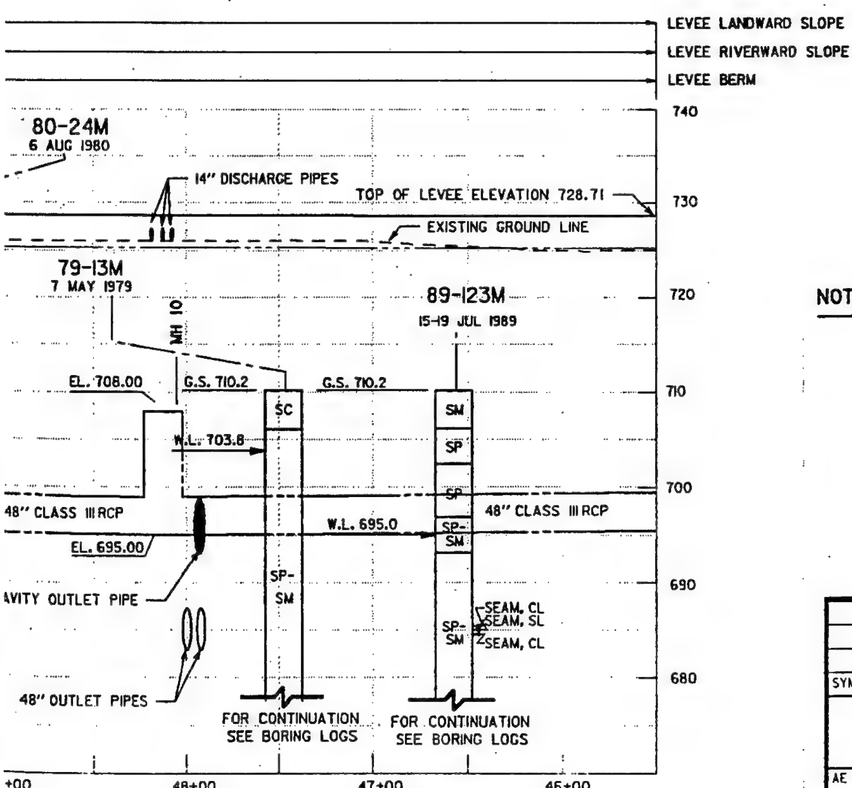
PROFILE





TYPICAL SECTION

STA. 53+60 TO STA. 57+00
TRAIL ON SIDE OF LEVEE
NO SCALE



NOTES:

1. ELEVATIONS REFER TO M.S.L. (1929 ADJ.)
2. COORDINATES AND GRID FOR PROJECT ARE LAMBERT GRID, MINNESOTA SOUTH ZONE.
3. ALL EXISTINGS UTILITIES BENEATH PROPOSED LEVEE SHALL BE RELOCATED.
4. SEE SITE PLAN SHEET FOR PUMPING STATION LAYOUT.
5. BUILDINGS TO BE REMOVED BY OTHERS. CONTRACTOR SHALL REMOVE SLAB AND FOUNDATION.
6. CONSTRUCT DRAINAGE SWALE INSIDE LEVEE BERM TO DIRECT RUNOFF INTO INTERCEPTOR PIPE INLETS.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

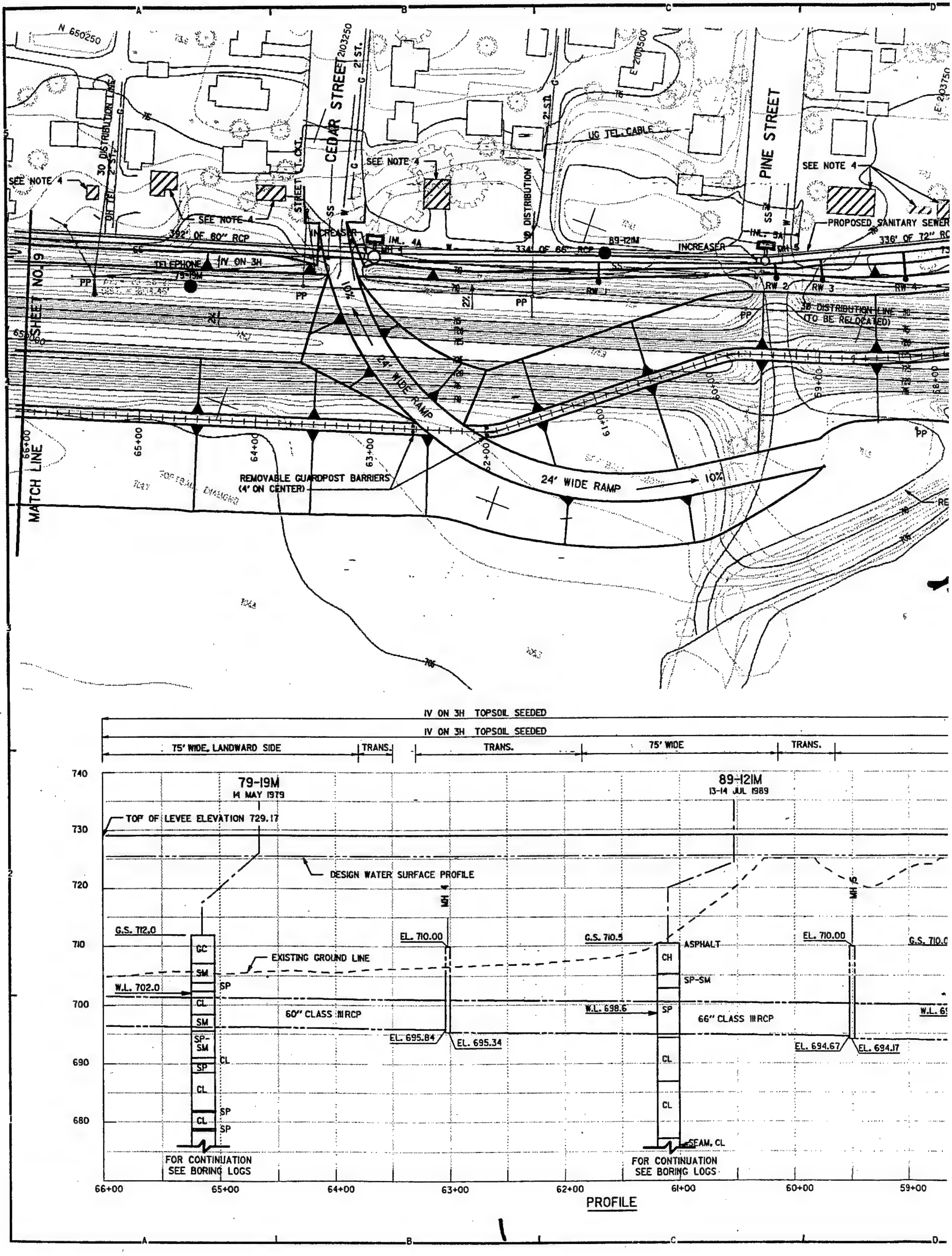
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL – MINNESOTA RIVER
CHASKA PROJECT — CHASKA, MINNESOTA
DRAINAGE & LEVEES
PLAN & PROFILE
STA. 45+50 TO 55+50

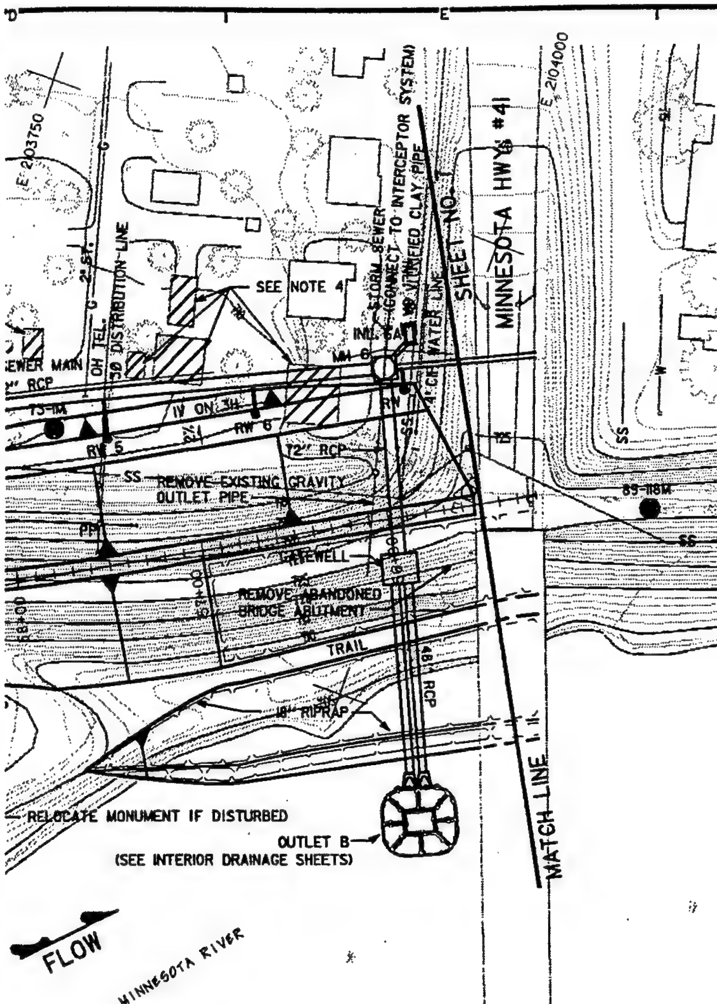
ED-D	DESIGNED:	R.J.M.
ED-D	CHECKED:	J.J.G.
ED-D	DRAWN:	T.J. - R.J.M.
ED-GH	DESIGNED:	W.J.M.-J.R.C.
ED-GH	CHECKED:	
DATE:	MARCH 1991	

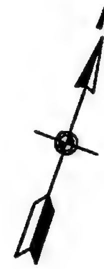
CAD FILE NAME: MNIOP006.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/206
SHT 7 OF 31

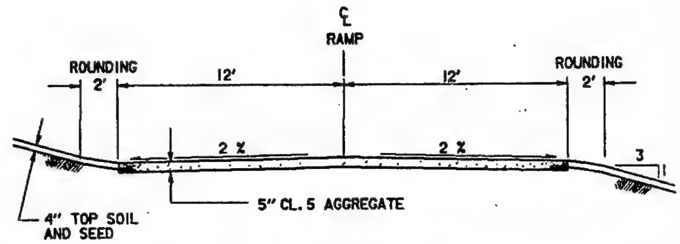
2



N 650250
CEDAR STREET
21 ST.
PINE STREET
SEE NOTE 4
30 DISTRIBUTION LINE
UG TEL. CABLE
392' OF 60" RCP
INCREASER
INL. 4A
MH 4
334' OF 66" RCP
89-12M
INL. 5A
MH 5
PROPOSED SANITARY SEWER
336' OF 72" RCP
TELEPHONE
IV ON 3H
79-19M
PP
RW 1
RW 2
RW 3
RW 4
30 DISTRIBUTION LINE
(TO BE RELOCATED)
MATCH LINE SHEET NO. 9
24' WIDE RAMP
10%
REMOVABLE GUARDPOST BARRIERS
(4' ON CENTER)
66+00
65+00
64+00
63+00
62+00
61+00
60+00
59+00
IV ON 3H TOPSOIL SEEDED
75' WIDE, LANDWARD SIDE
TRANS.
75' WIDE
79-19M
14 MAY 1979
89-12IM
13-14 JUL 1989
TOP OF LEVEE ELEVATION 729.17
DESIGN WATER SURFACE PROFILE
MH 4
MH 5
G.S. 712.0
EL. 710.00
G.S. 710.5
ASPHALT
G.S. 710.0
EXISTING GROUND LINE
W.L. 702.0
W.L. 698.6
60" CLASS III RCP
66" CLASS III RCP
EL. 695.84
EL. 695.34
EL. 694.67
EL. 694.17
GC
SM
SP
CL
SP-SM
CH
SEAM, CL
FOR CONTINUATION SEE BORING LOGS
740
730
720
710
700
690
680
PROFILE







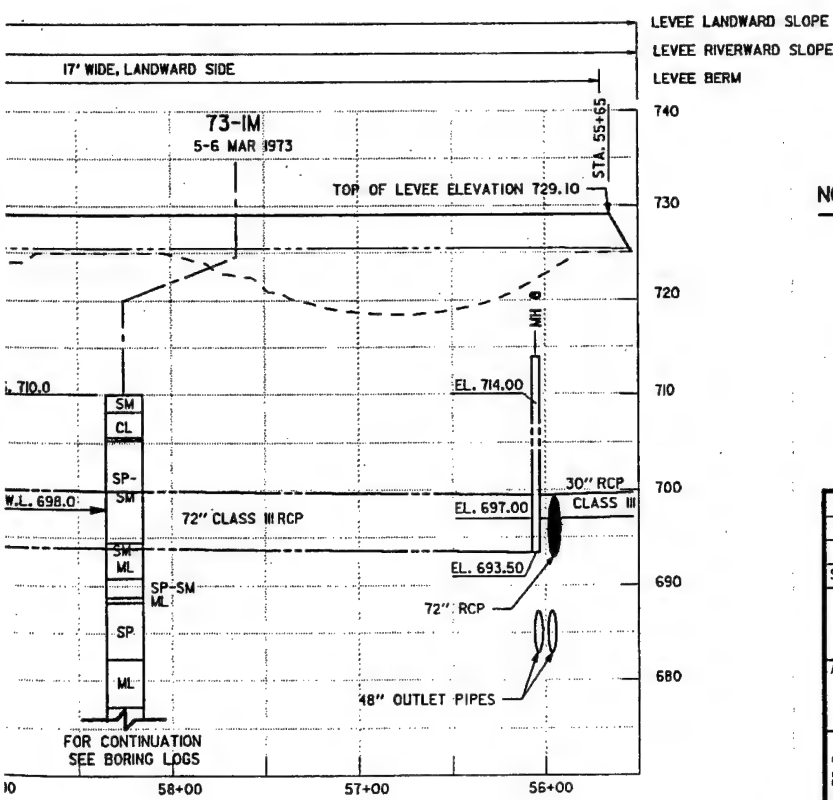
TYPICAL SECTION

RAMP

PLAN VIEW

50 0 50 100

SCALE IN FEET



NOTES:

1. ELEVATIONS REFER TO M.S.L. (1929 ADJ.)
2. COORDINATES AND GRID FOR PROJECT ARE LAMBERT GRID, MINNESOTA SOUTH ZONE.
3. FOR WELL SPACING AND DEPTH SEE SHEET 20.
4. BUILDINGS TO BE REMOVED BY OTHERS. SLAB AND FOUNDATION REMOVED BY CONTRACTOR.
5. CONSTRUCT DRAINAGE SWALE ALONG INSIDE OF LEVEE BERM TO DIRECT RUNOFF INTO INTERCEPTOR PIPE INLETS.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL – MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA

DRAINAGE & LEVEES
PLAN & PROFILE
STA. 55+50 TO 66+00

ED-D	DESIGNED:	R.J.M.
ED-D	CHECKED:	J.J.G.
ED-D	DRAWN:	T.J. - R.J.M.
ED-CH	DESIGNED:	W.J.M.-J.R.C.
ED-CH	CHECKED:	

DATE: MARCH 1991

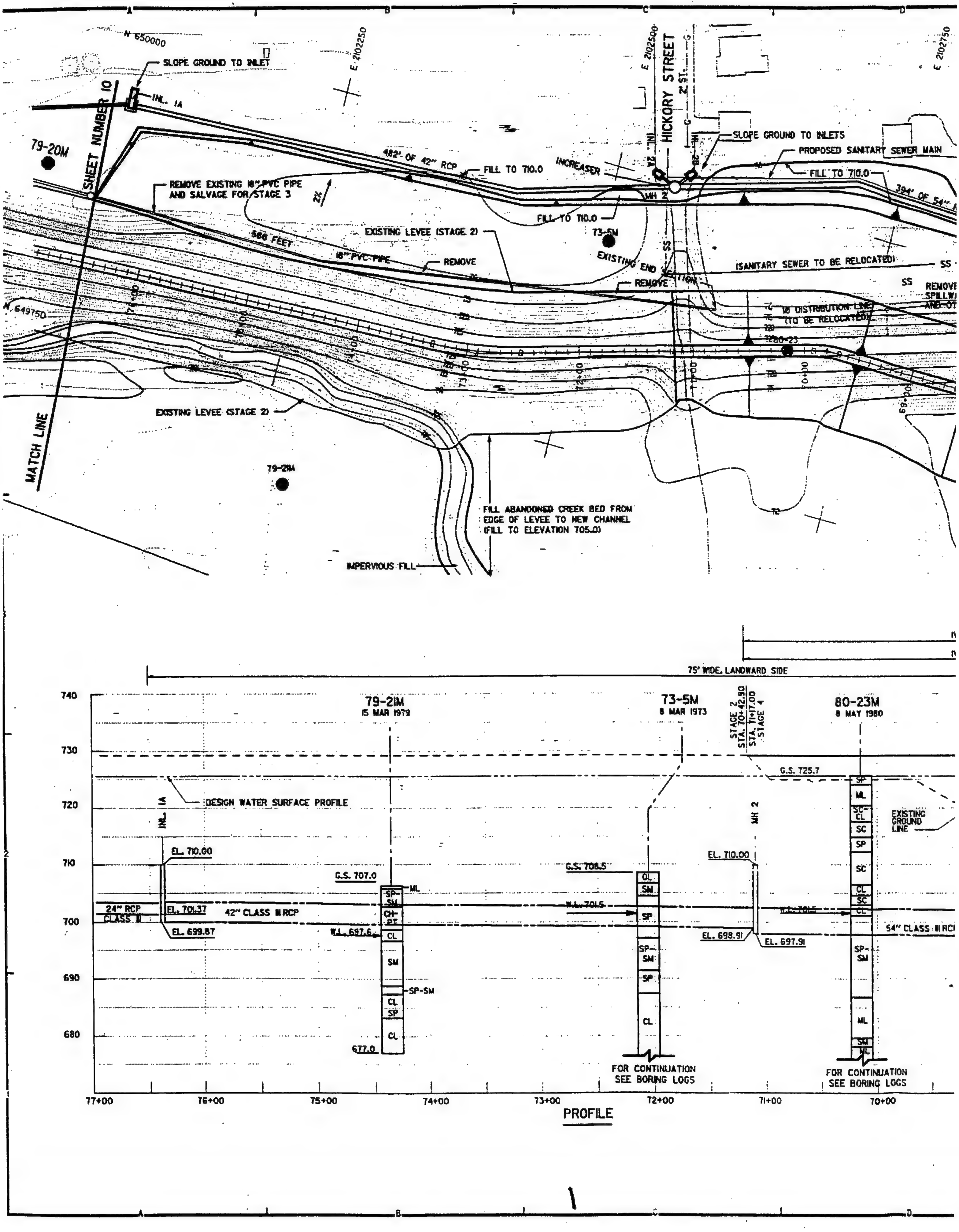
CAD FILE NAME: MNIOPOO7.DGN

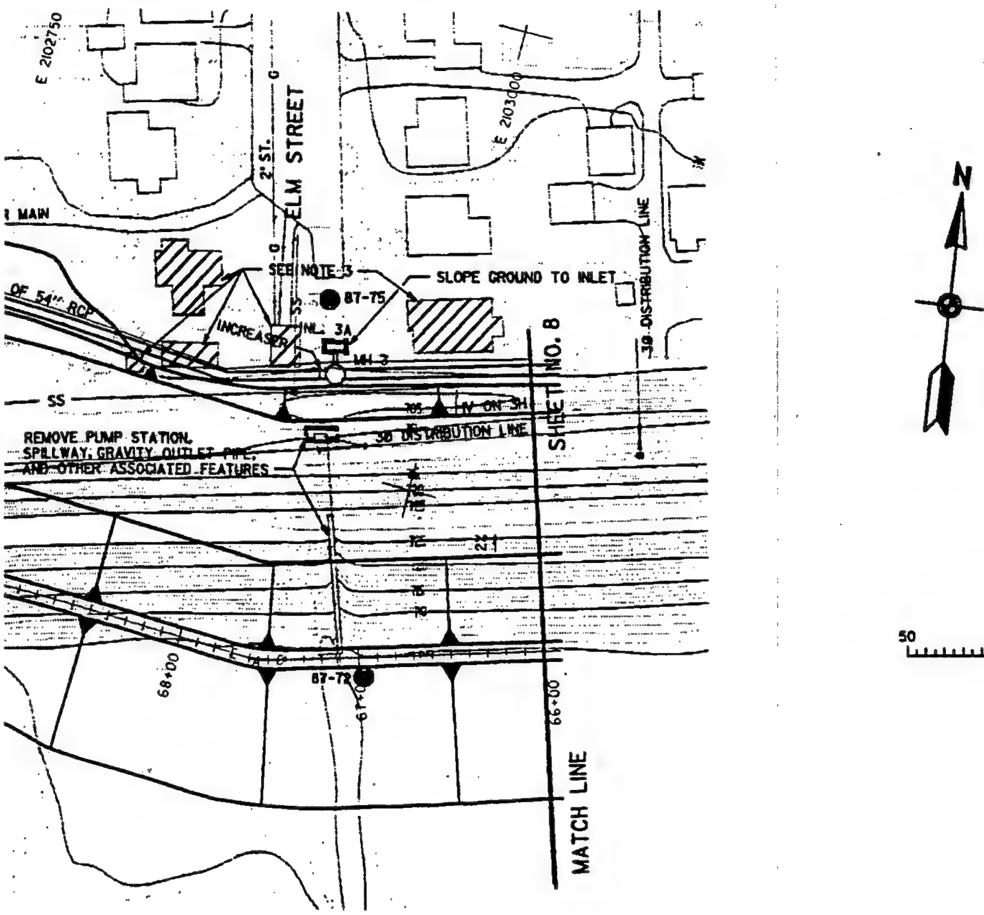
SPEC NO:

DRAWING NUMBER: MN34-CH-R-5/207

SHT 8 OF 31

2

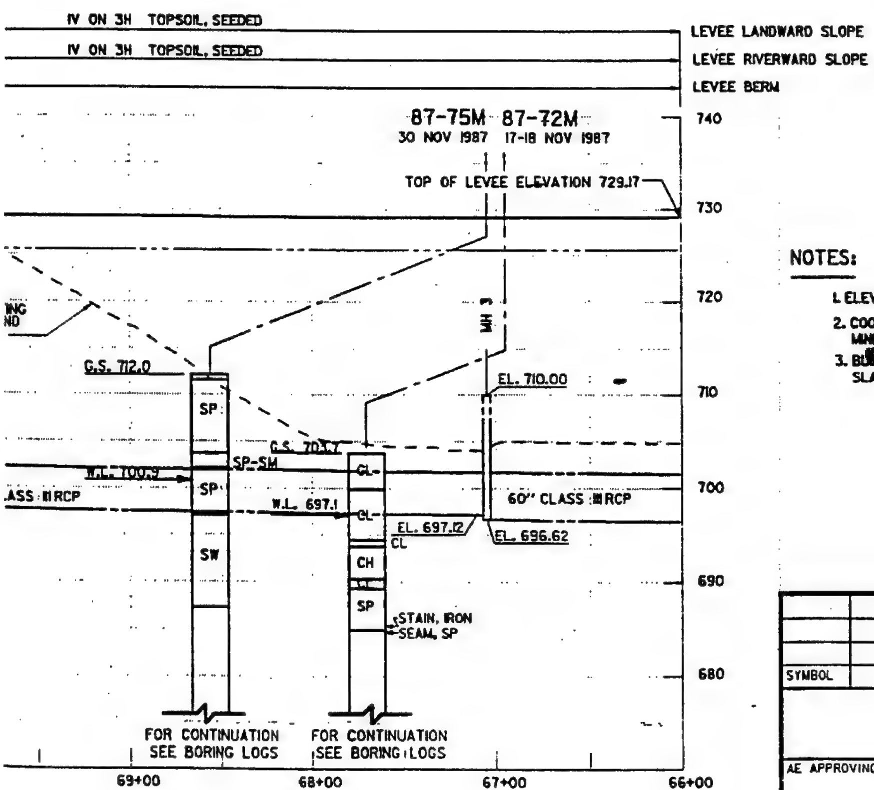

N 650000
SLOPE GROUND TO INLET
E 2102250
E 2102500
E 2102750
HICKORY STREET
2d ST.
SHEET NUMBER 10
INL. 1A
79-20M
INL. 2A
INL. 2B
SLOPE GROUND TO INLETS
PROPOSED SANITARY SEWER MAIN
482' OF 42" RCP
FILL TO 710.0
INCREASER
MH 2
FILL TO 710.0
394' OF 54"
REMOVE EXISTING 18" PVC PIPE AND SALVAGE FOR STAGE 3
FILL TO 710.0
EXISTING LEVEE (STAGE 2)
73-5M
568 FEET
18" PVC PIPE
REMOVE
EXISTING END SECTION
(SANITARY SEWER TO BE RELOCATED)
REMOVE
SS
10 DISTRIBUTION LINE (TO BE RELOCATED)
N 649750
80-23M
EXISTING LEVEE (STAGE 2)
MATCH LINE
79-21M
FILL ABANDONED CREEK BED FROM EDGE OF LEVEE TO NEW CHANNEL (FILL TO ELEVATION 705.0)
IMPERVIOUS FILL
75' WIDE, LANDWARD SIDE
79-21M
15 MAR 1979
73-5M
8 MAR 1973
STAGE 2
STA. 70+42.90
STA. 71+17.00
STAGE 4
80-23M
8 MAY 1980
740
730
720
710
700
690
680
G.S. 725.7
DESIGN WATER SURFACE PROFILE
INL. 1A
MH 2
EXISTING GROUND LINE
EL. 710.00
G.S. 707.0
G.S. 708.5
EL. 710.00
24" RCP CLASS III
EL. 701.37
42" CLASS III RCP
W.L. 701.5
W.L. 701.5
EL. 699.87
W.L. 697.6
EL. 698.91
EL. 697.91
54" CLASS III RCP
ML
SP-SM
CH-PT
CL
SM
SP-SM
CL
SP
CL
677.0
OL
SM
SP
SP-SM
SP
CL
SP
ML
SC-CL
SC
SP
SC
CL
SC
CL
SP-SM
ML
SM
ML
FOR CONTINUATION SEE BORING LOGS
FOR CONTINUATION SEE BORING LOGS
77+00
76+00
75+00
74+00
73+00
72+00
71+00
70+00
PROFILE



PLAN VIEW

50 0 50 100

SCALE IN FEET



NOTES:

1. ELEVATIONS REFER TO M.S.L. (1929 ADJ.)
2. COORDINATES AND GRID FOR PROJECT ARE LAMBERT GRID. MINNESOTA SOUTH ZONE.
3. BUILDINGS TO BE REMOVED BY OTHERS. CONTRACTOR SHALL REMOVE SLAB AND FOUNDTAION.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

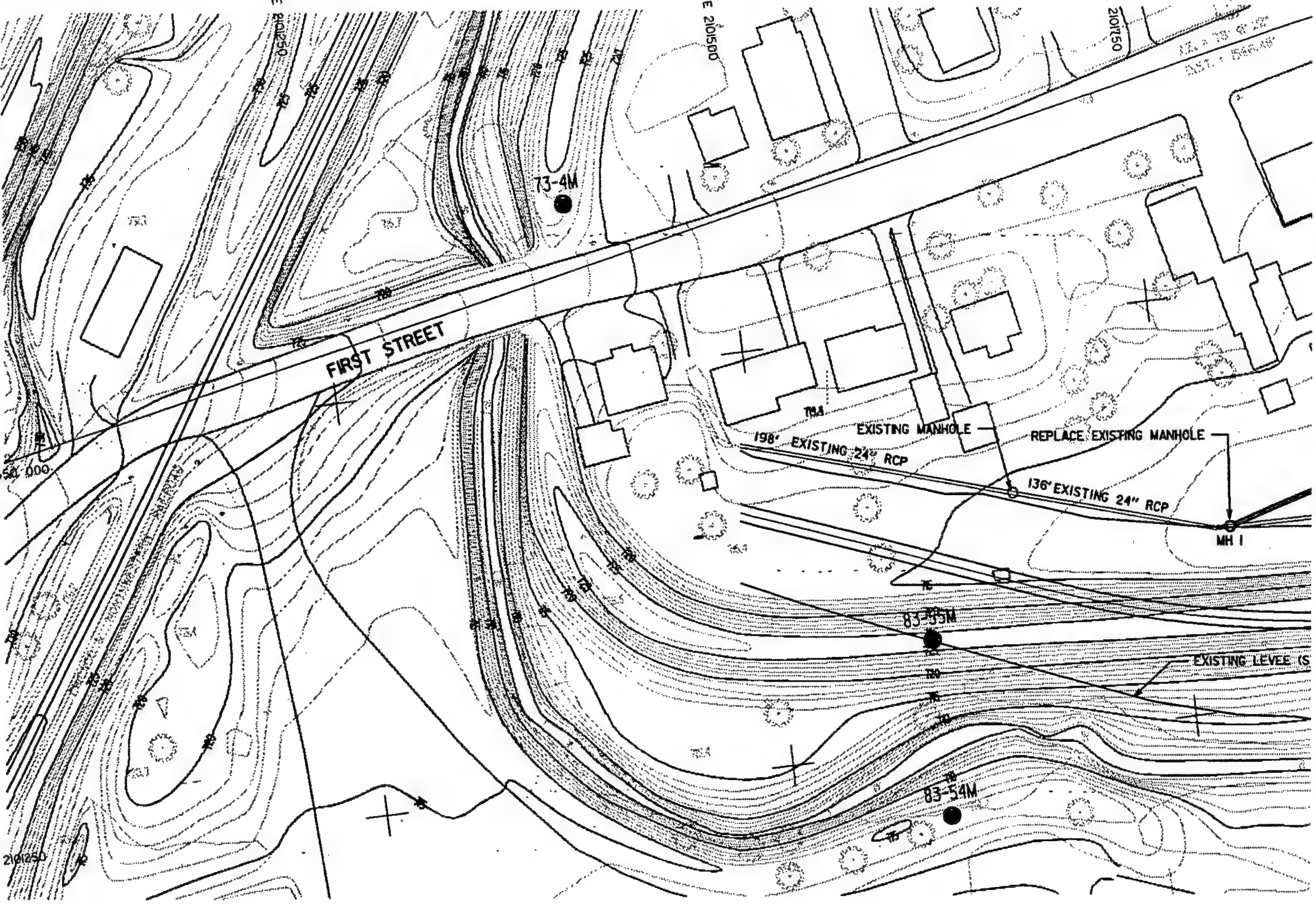
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL – MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
DRAINAGE & LEVEES
PLAN & PROFILE
STA. 66+00 TO 76+50

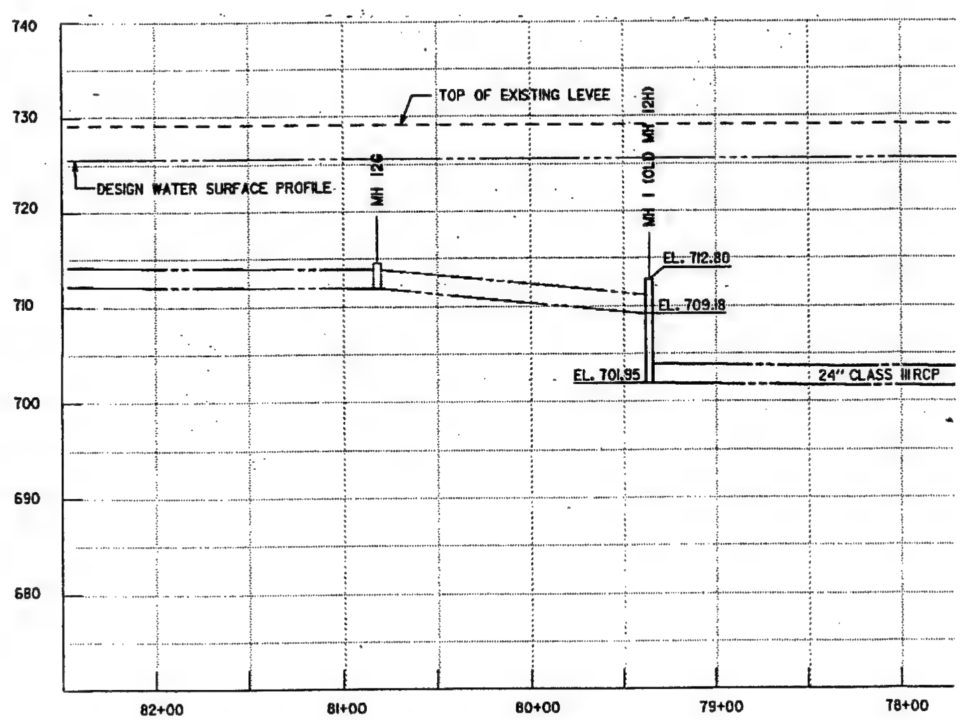
ED-D	DESIGNED:	R.J.M.
ED-D	CHECKED:	J.J.C.
ED-D	DRAWN:	T.J. - R.J.M.
ED-GH	DESIGNED:	W.J.M.-J.R.C.
ED-GH	CHECKED:	
	DATE:	MARCH 1991

CAD FILE NAME: MNIOP008.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/208
SHT 9 OF 31

2

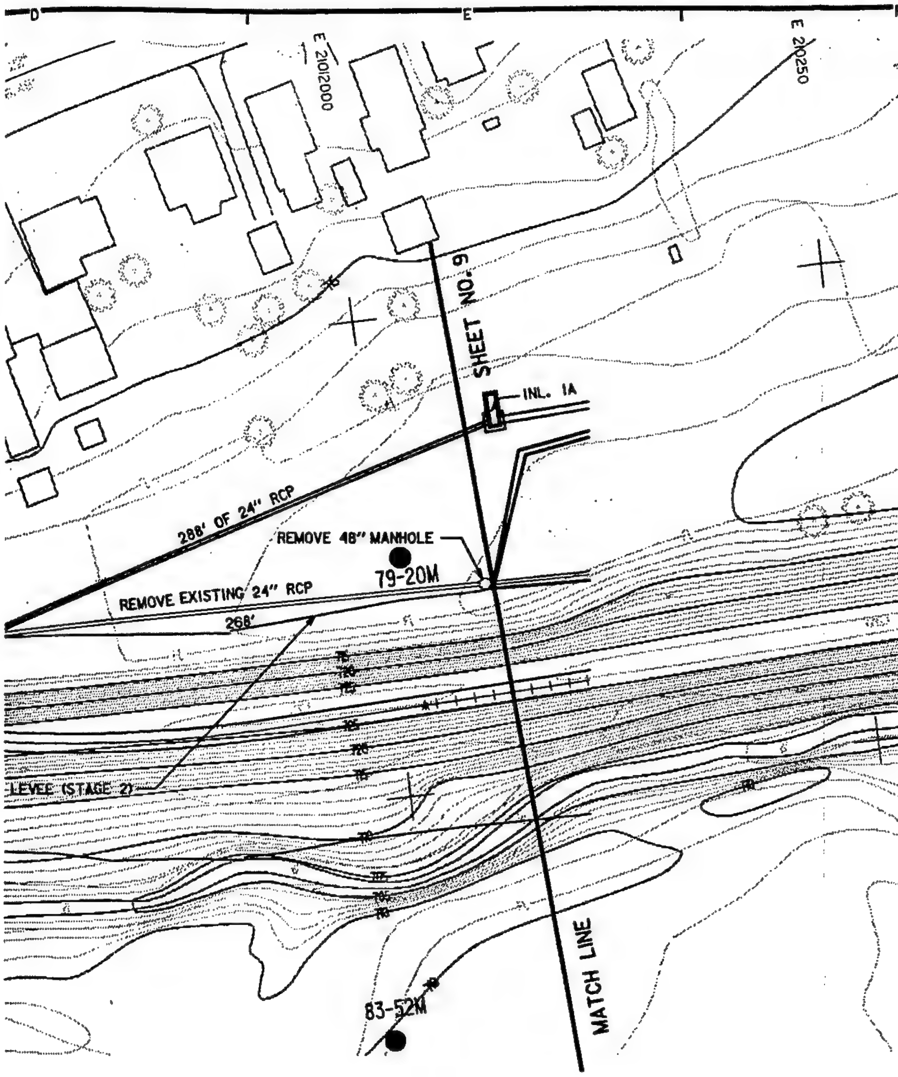


E 2101250
E 2101500
E 2101750
73-4M
FIRST STREET
N 650 000
N 2101250
EXISTING MANHOLE
REPLACE EXISTING MANHOLE
198' EXISTING 24" RCP
136' EXISTING 24" RCP
MH 1
83-55M
EXISTING LEVEE
83-54M



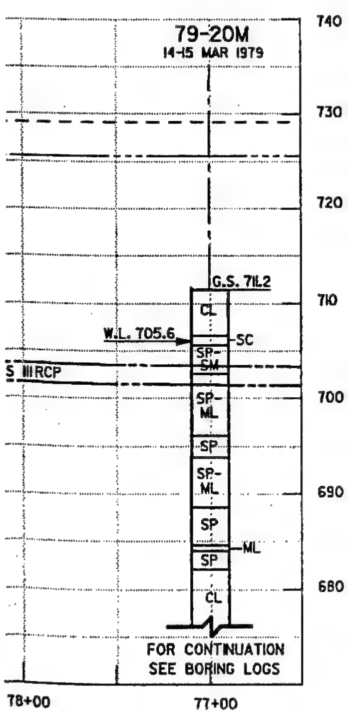
740
730
720
710
700
690
680
TOP OF EXISTING LEVEE
DESIGN WATER SURFACE PROFILE
MH 12G
MH 1 (OLD MH 12H)
EL. 712.80
EL. 709.18
EL. 701.95
24" CLASS III RCP
82+00
81+00
80+00
79+00
78+00

PROFILE



PLAN VIEW

50 0 50 100
SCALE IN FEET



NOTES:

1. ELEVATIONS REFER TO M.S.L. (1929 ADJ.)
2. COORDINATES AND GRID FOR PROJECT ARE LAMBERT GRID, MINNESOTA SOUTH ZONE.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
DRAINAGE & LEVEES
PLAN & PROFILE
STA. 76+50 TO 82+50

ED-D: DESIGNED: R.J.M. CHECKED: J.J.G. DRAWN: T.J. - R.J.M.
ED-GH: DESIGNED: W.J.M.-J.R.C. CHECKED:

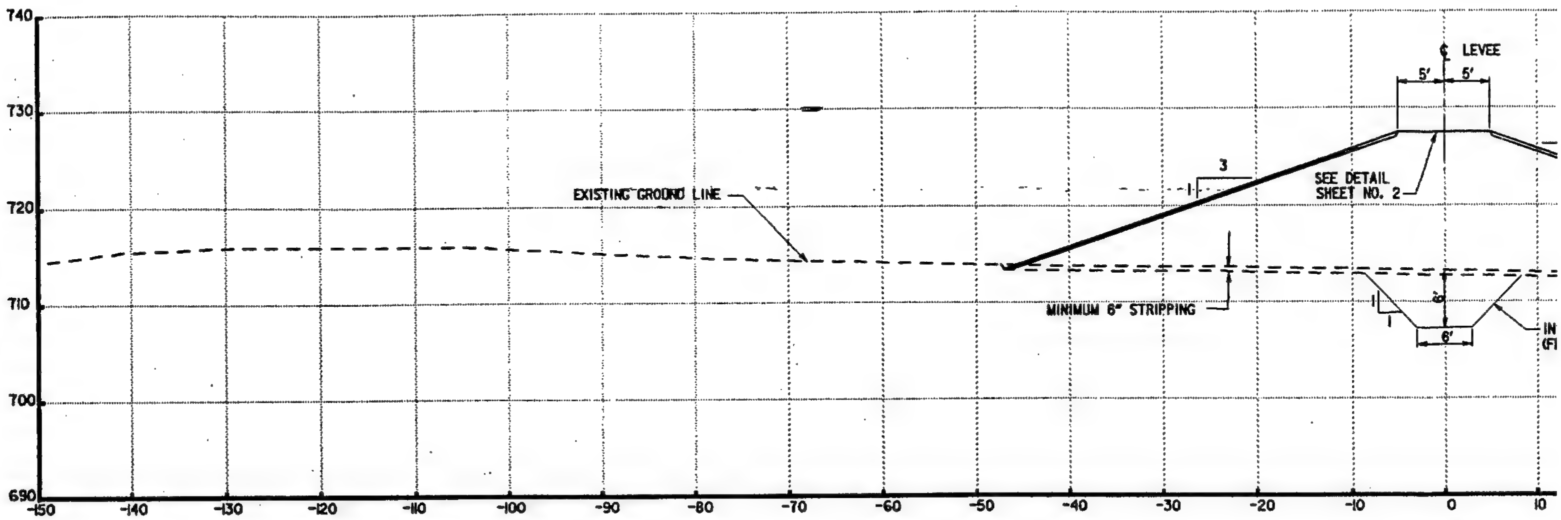
DATE: MAR 1991

CAD FILE NAME: MNIOP009.DGN
SPEC NO:

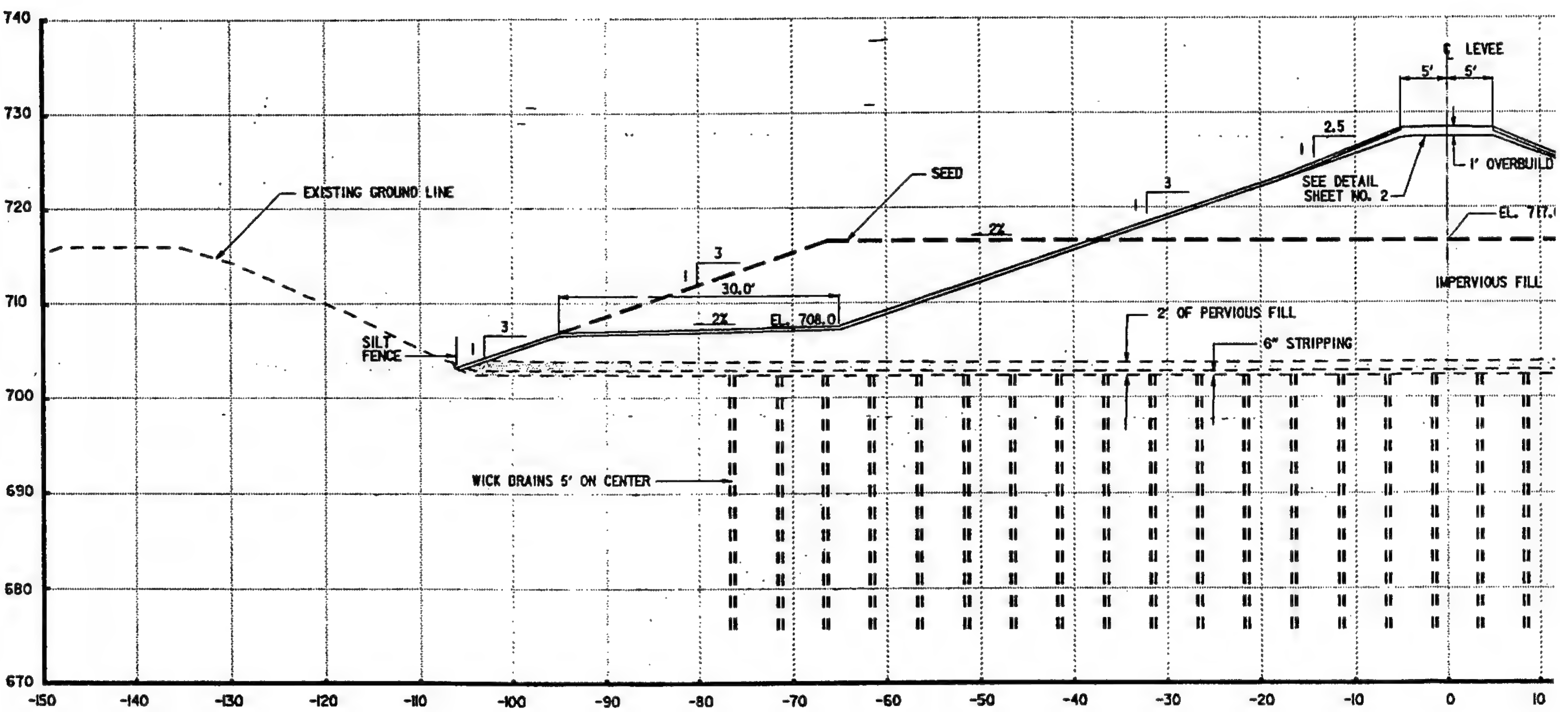
DRAWING NUMBER: M34-CH-R-5/209

SHT 10 OF 31

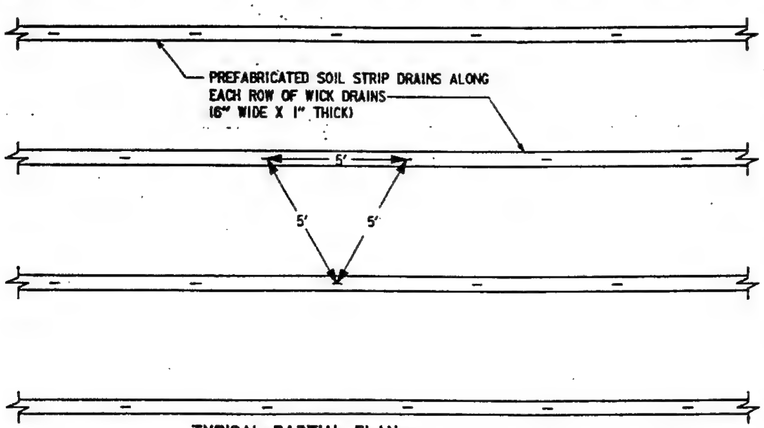
2



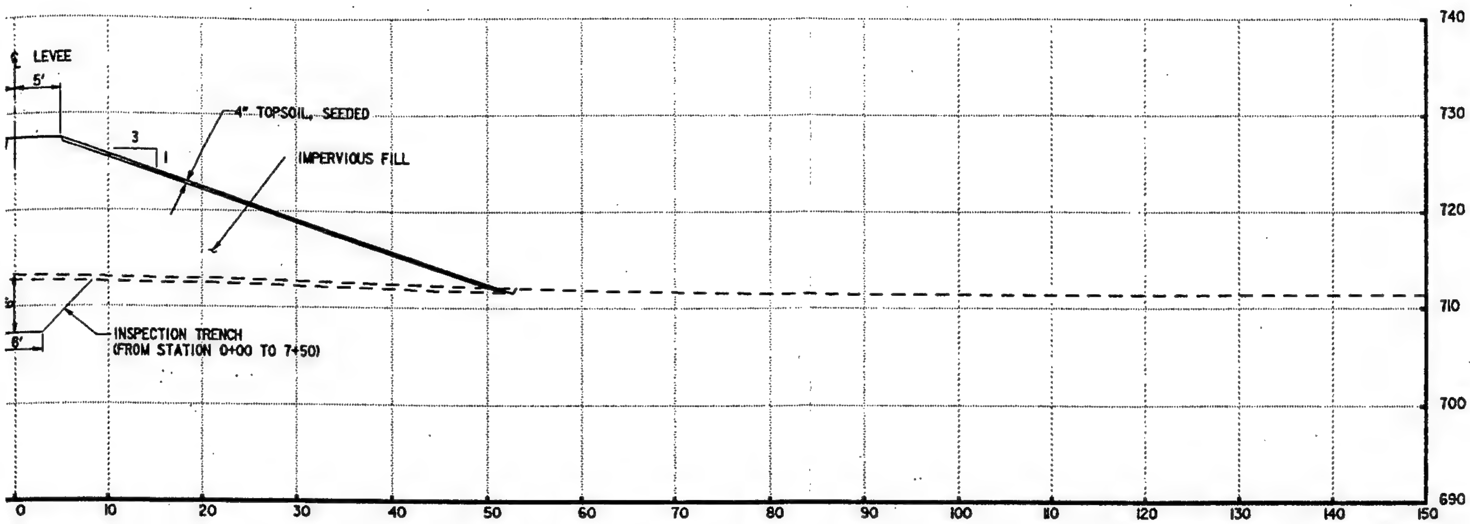
STATION 4+00



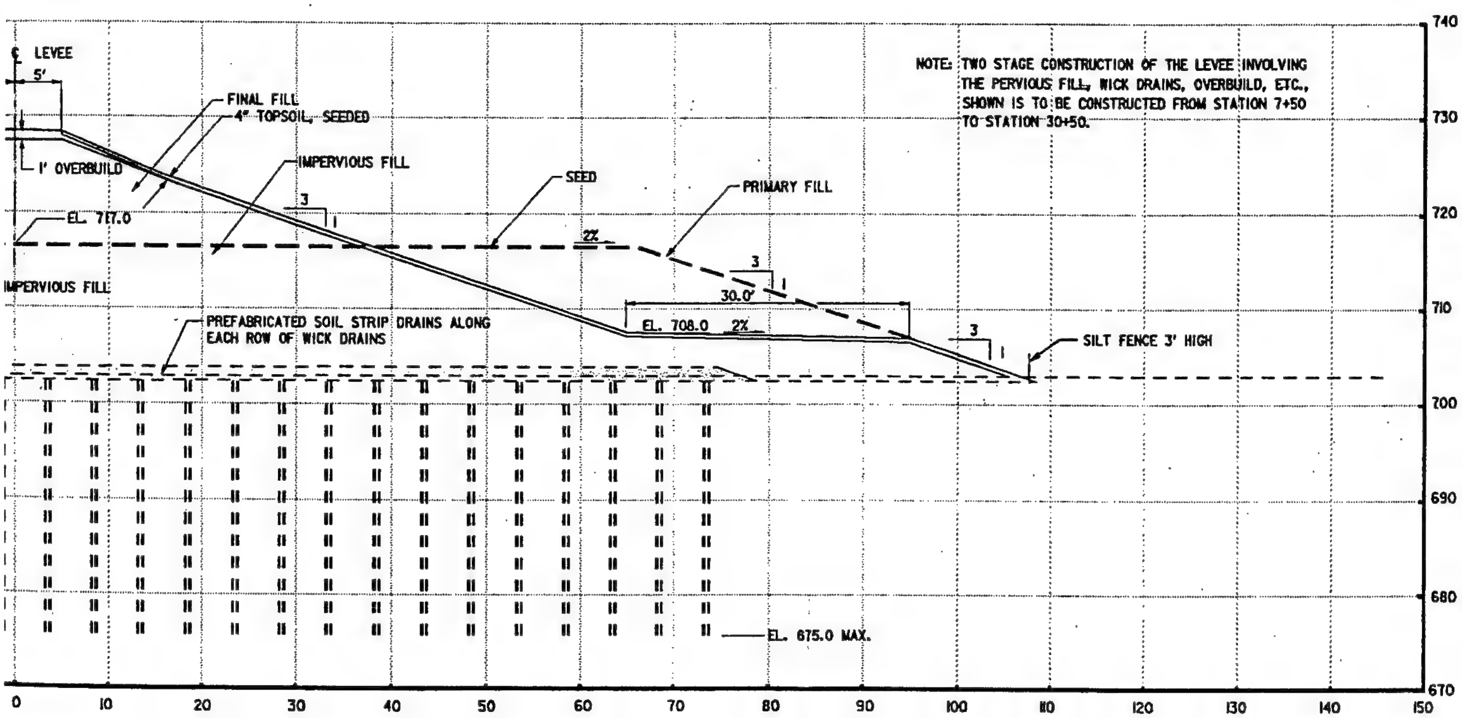
STATION 14+00



TYPICAL PARTIAL PLAN
WICK DRAINS
NO SCALE



ION 4+00



N 14+00

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL – MINNESOTA RIVER
CHASKA PROJECT — CHASKA, MINNESOTA

DRAINAGE AND LEVEES
LEVEE CROSS SECTIONS
STA. 4+00, 14+00, & 24+00

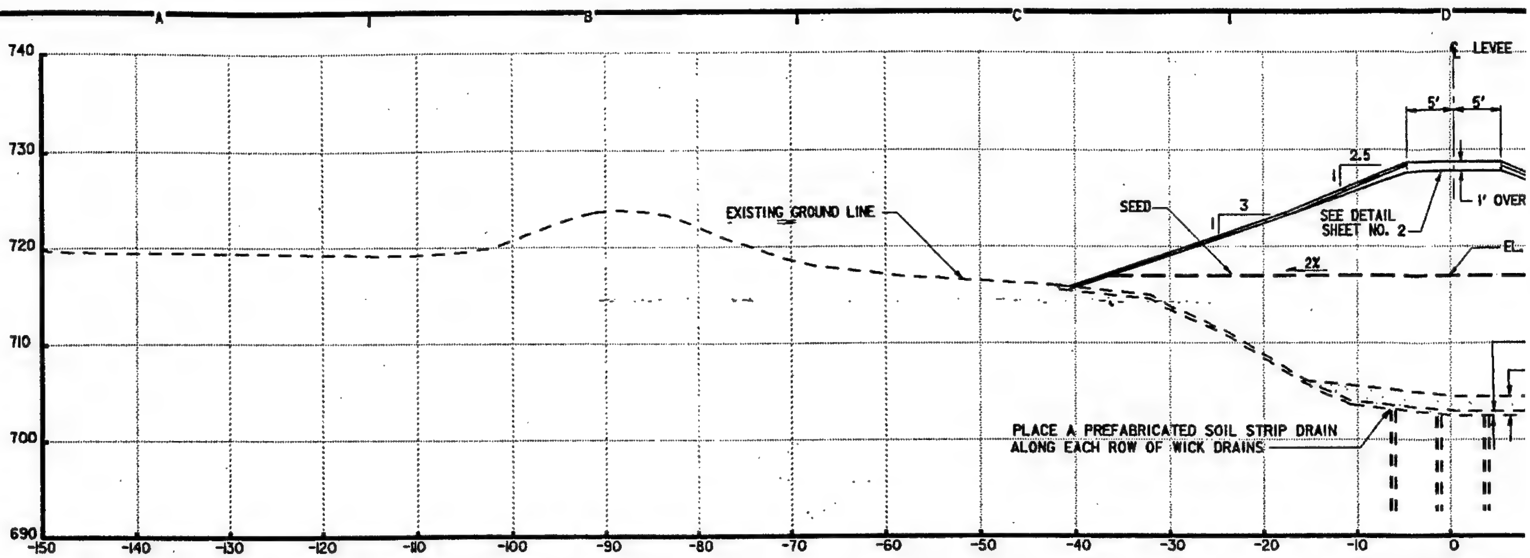
ED-D
DESIGNED: R.J.M.
CHECKED: J.J.G.
DRAWN: T.J.

ED-GH
DESIGNED: J.R.C.
CHECKED:

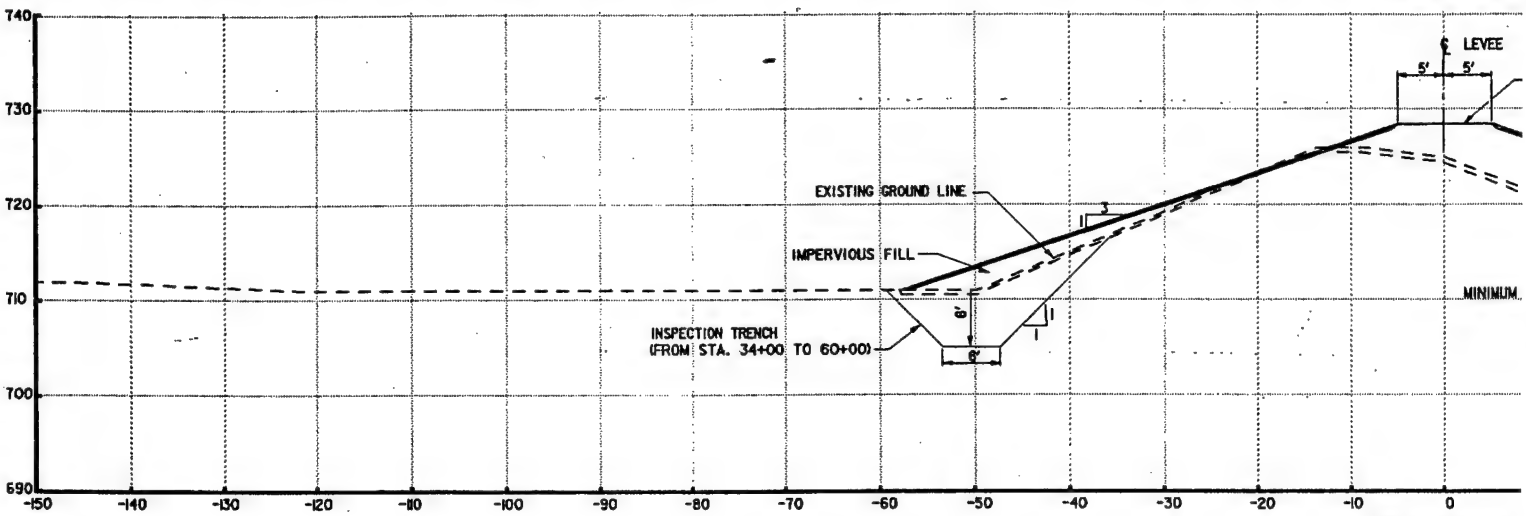
DATE: MARCH 1991

CAD FILE NAME: MNIOPXSI.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/210
SHT 8 OF 31

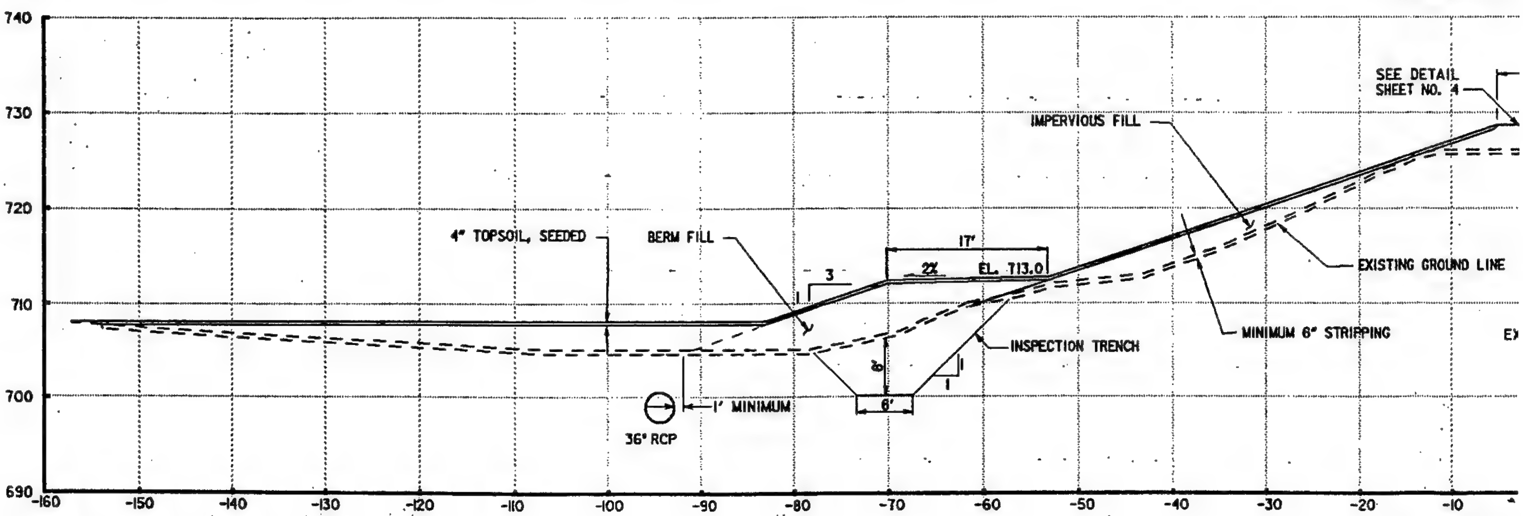
2



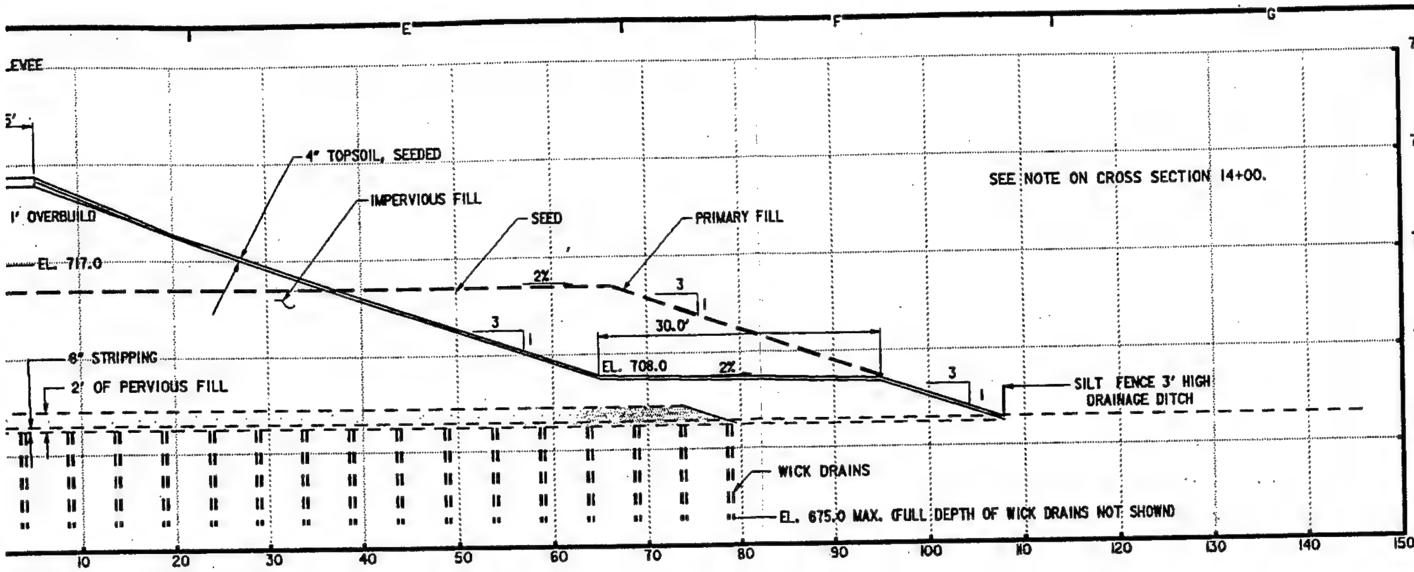
STATION 24+0(



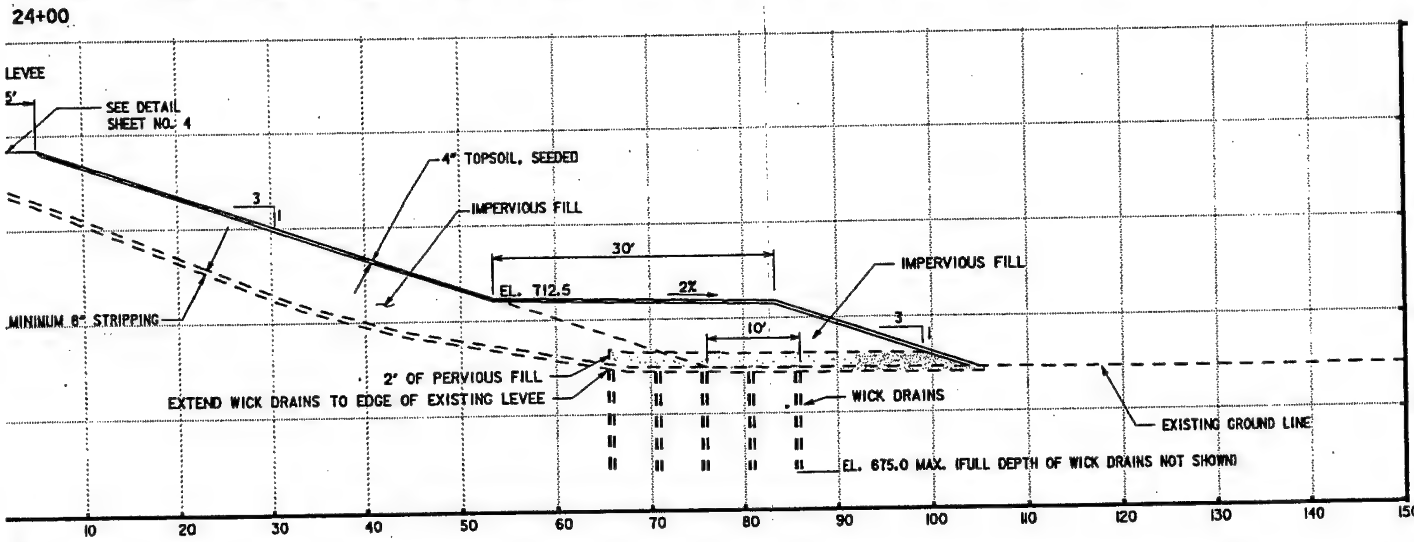
STATION 36+00



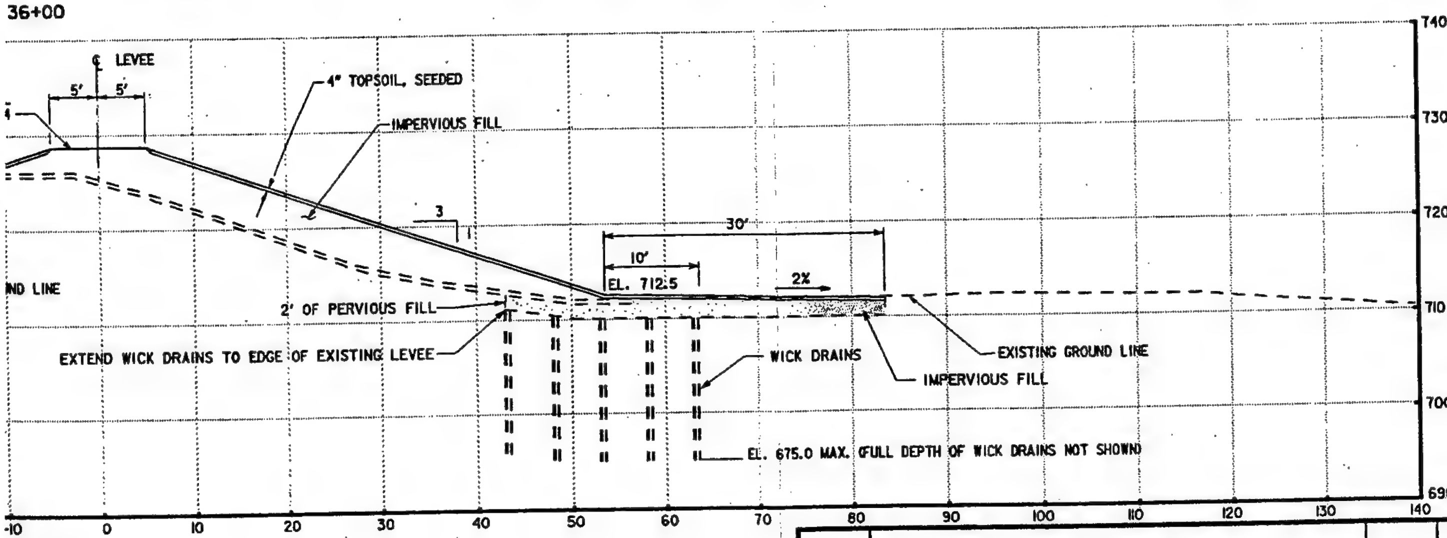
STATION 42+00



24+00



36+00



42+00

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

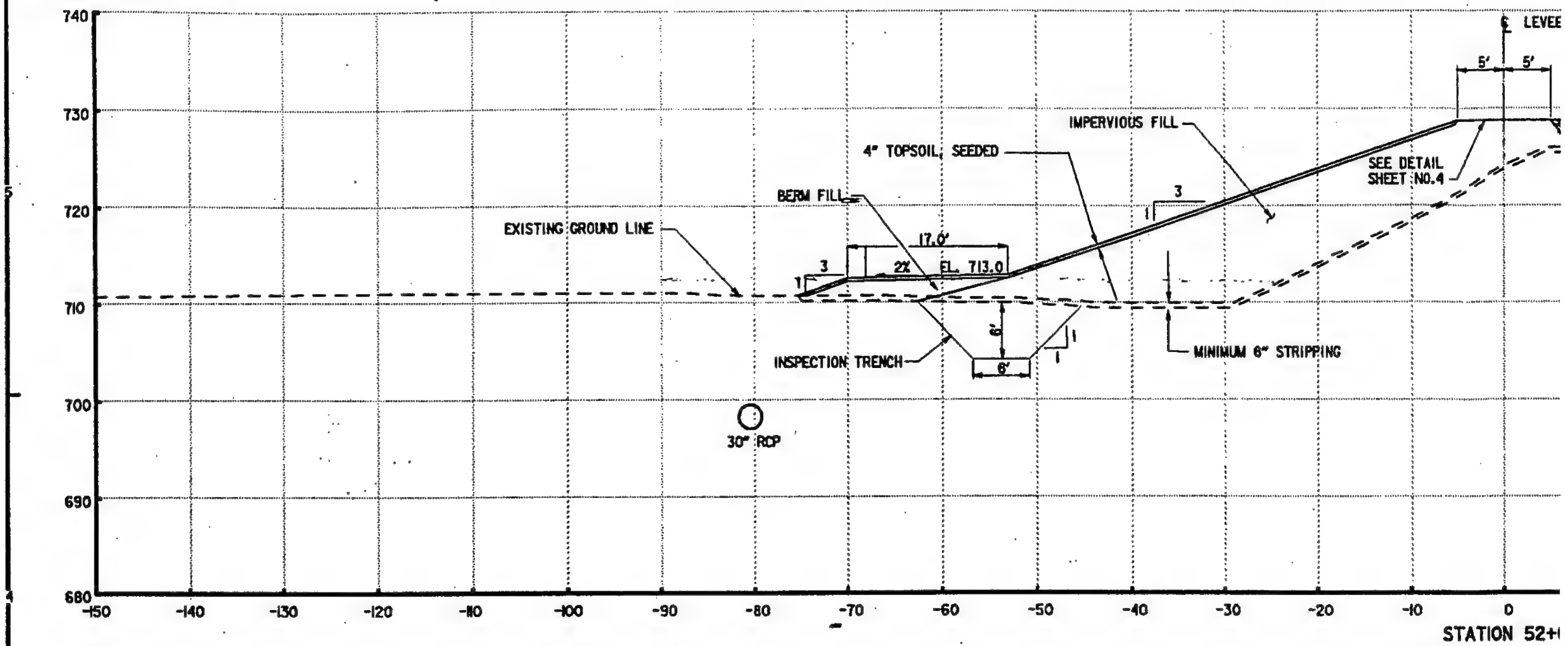
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL – MINNESOTA RIVER
CHASKA PROJECT — CHASKA, MINNESOTA
DRAINAGE AND LEVEES
LEVEE CROSS SECTIONS
STA. 24+00, 36+00, AND 42+00

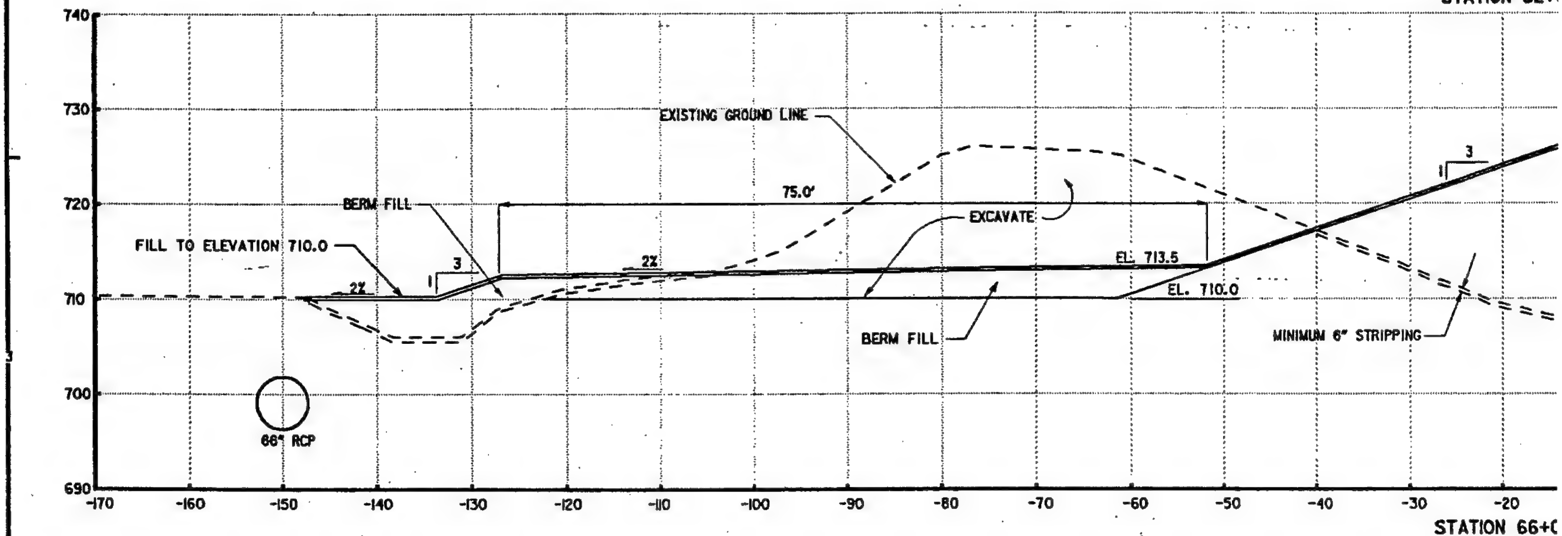
ED-D	DESIGNED:	R.J.M.
ED-D	CHECKED:	J.J.G.
ED-D	DRAWN:	T.J.
ED-GH	DESIGNED:	J.R.C.
ED-GH	CHECKED:	
	DATE:	MARCH 1991

CAD FILE NAME: MNIOPXS2.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/211
SHT 12 OF 31

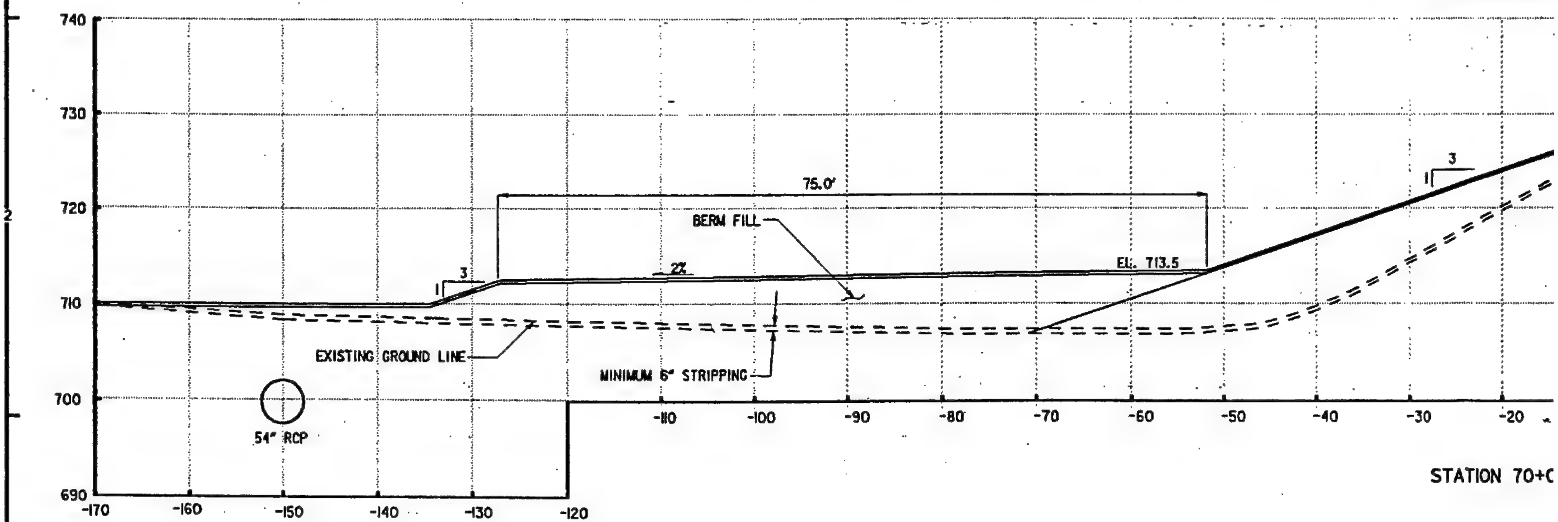
2



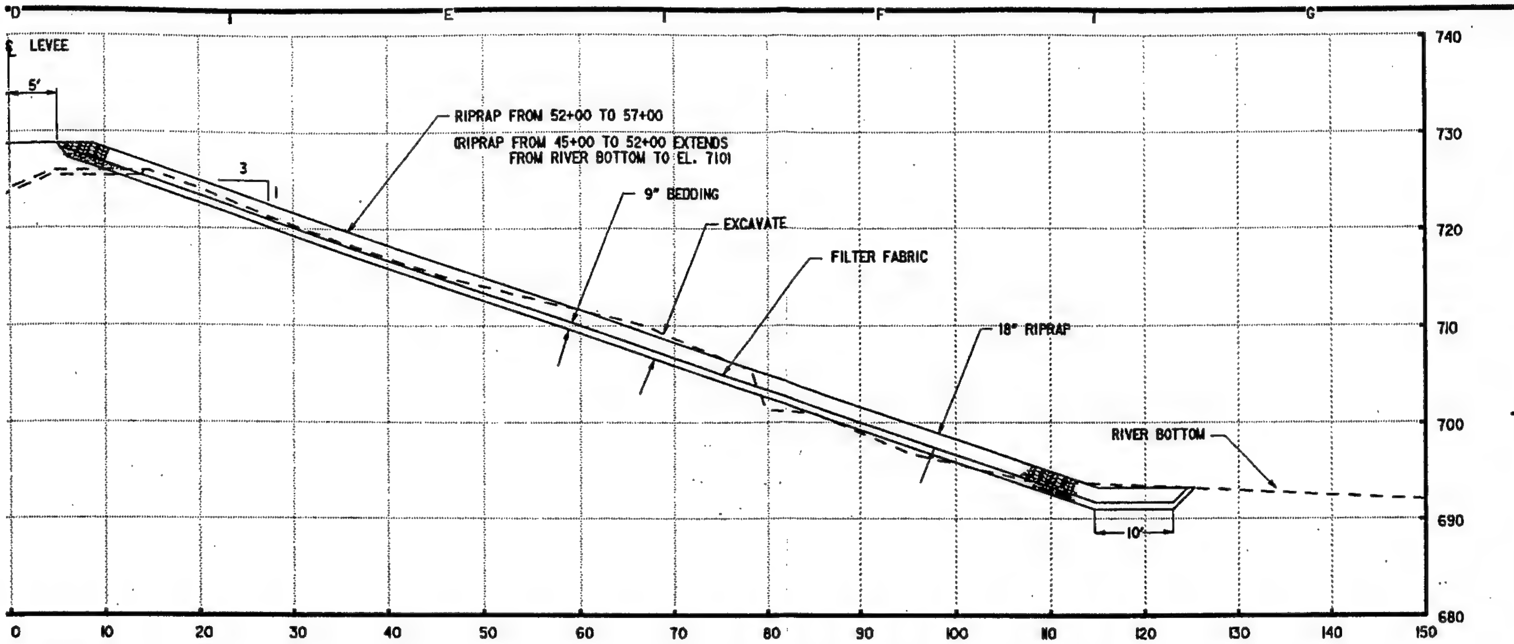
LEVEE
5'
5'
IMPERVIOUS FILL
4" TOPSOIL, SEEDED
SEE DETAIL SHEET NO.4
BERM FILL
EXISTING GROUND LINE
17.0'
2%
EL. 713.0
INSPECTION TRENCH
6'
6'
MINIMUM 6" STRIPPING
30" RCP
STATION 52+



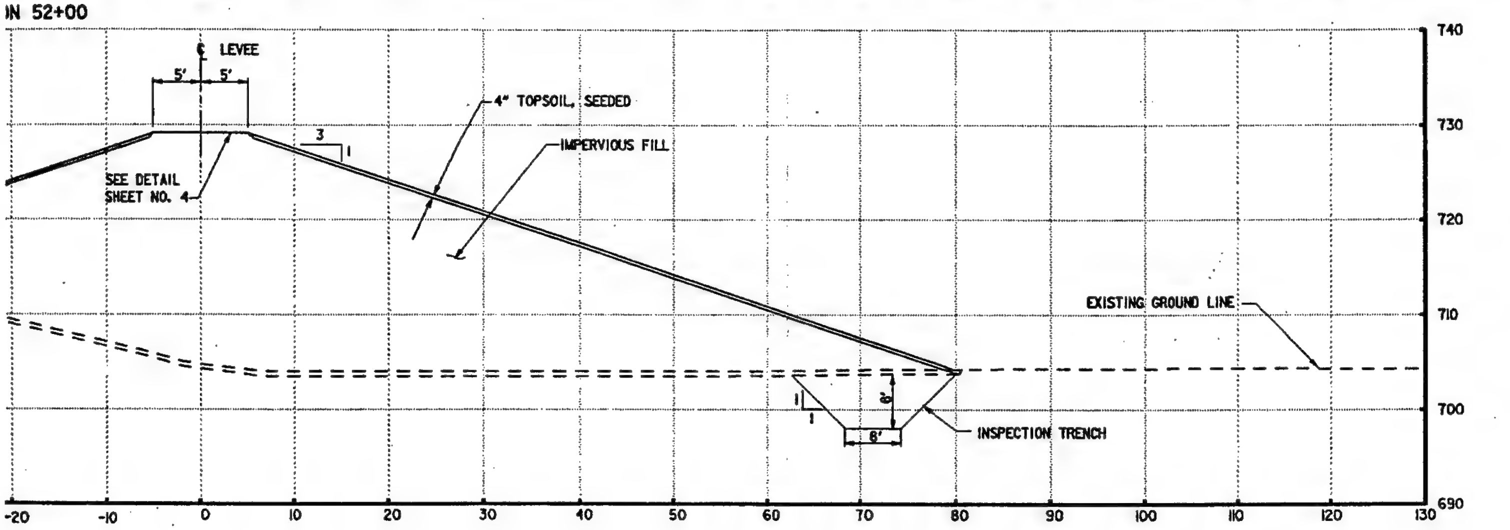
EXISTING GROUND LINE
75.0'
BERM FILL
EXCAVATE
FILL TO ELEVATION 710.0
2%
2%
EL. 713.5
EL. 710.0
BERM FILL
MINIMUM 6" STRIPPING
66" RCP
STATION 66+



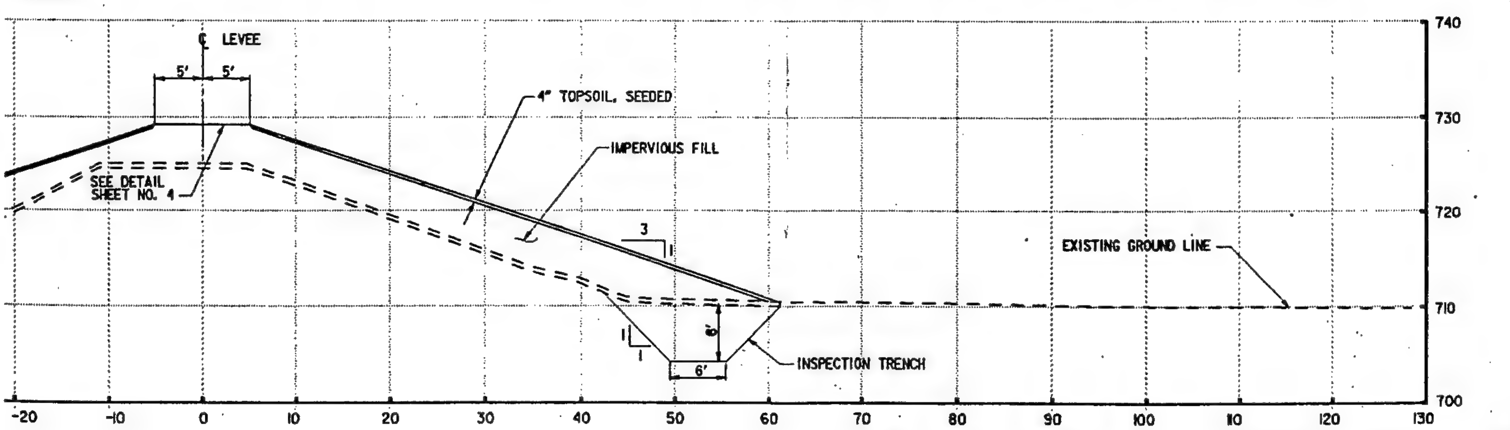
75.0'
BERM FILL
2%
EL. 713.5
EXISTING GROUND LINE
MINIMUM 6" STRIPPING
54" RCP
STATION 70+



N 52+00



N 66+00



N 70+00

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

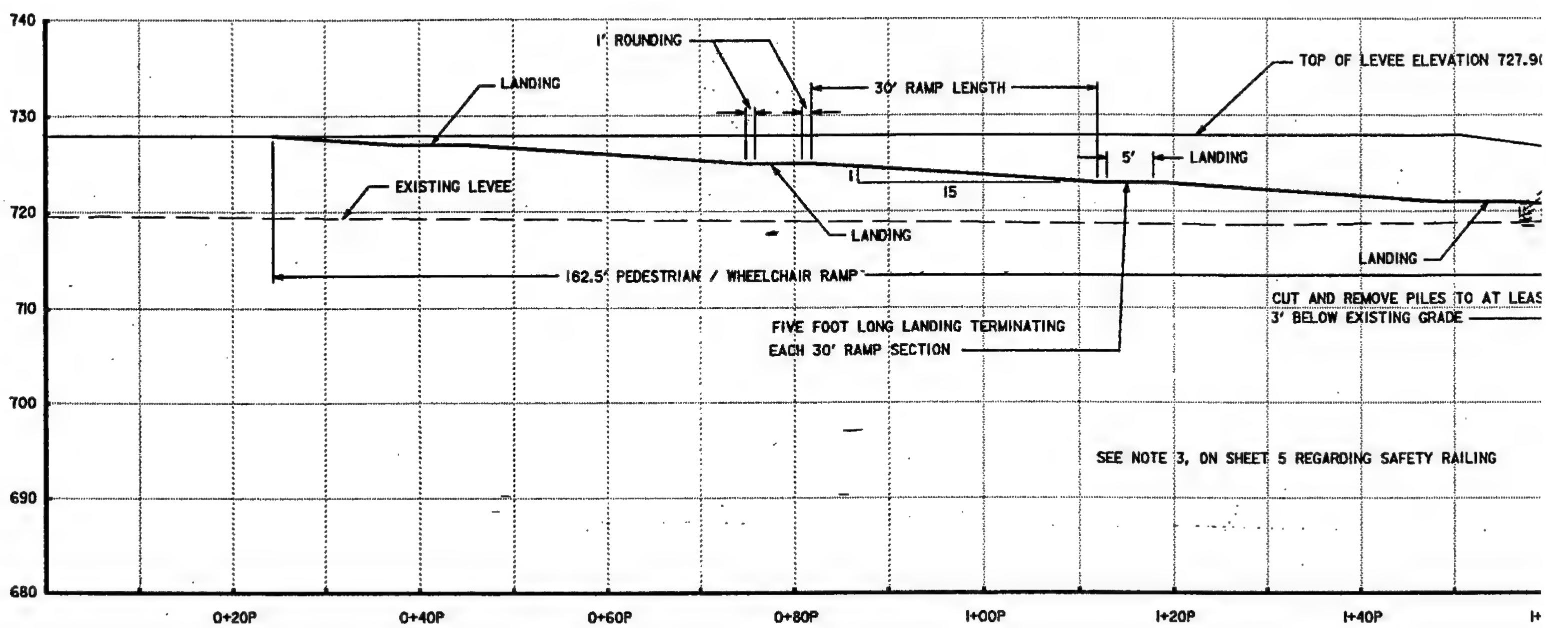
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
DRAINAGE AND LEVEES
LEVEE CROSS SECTIONS
STA. 52+00, 66+00, AND 70+00

ED-D	DESIGNED:	R.J.M.
ED-D	CHECKED:	J.J.G.
ED-D	DRAWN:	T.J.
ED-GH	DESIGNED:	J.R.C.
ED-GH	CHECKED:	
DATE:	MARCH 1991	

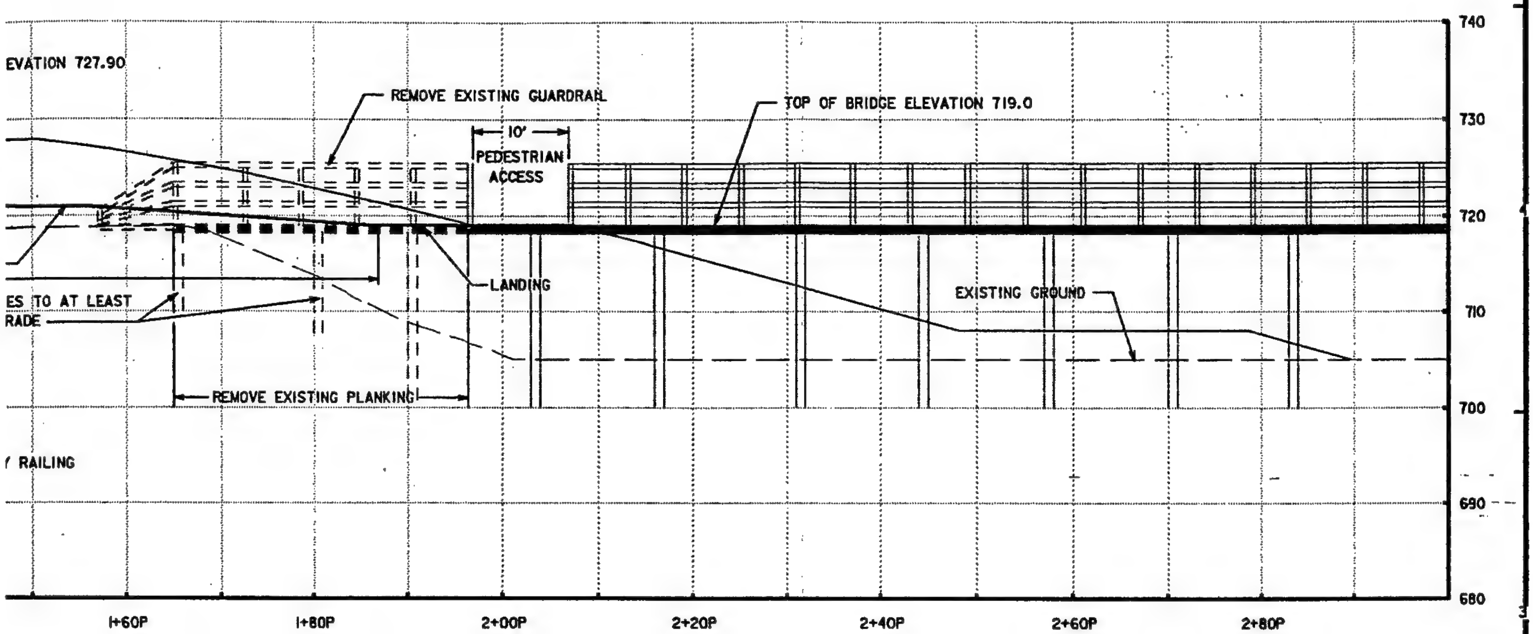
CAD FILE NAME: MN10PXS3.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/212
SHT 13 OF 31

2



PROFILE

PEDESTRIAN / WHEELCHAIR RAMP



IR RAMP

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

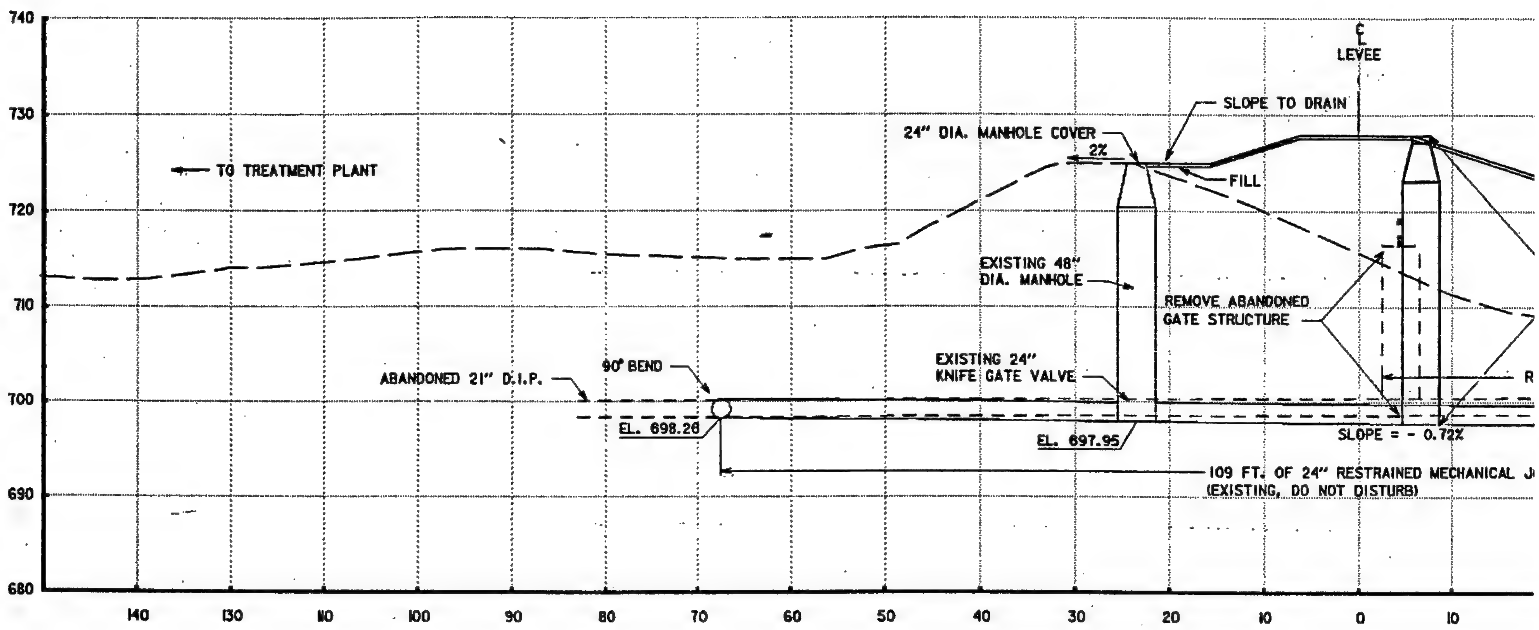
DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA

PROFILE
PEDESTRIAN BRIDGE APPROACH

ED-D: DESIGNED: R.J.M. CHECKED: J.J.G. DRAWN: R.J.M.
ED-GH: DESIGNED: CHECKED:
DATE: 05-22-90

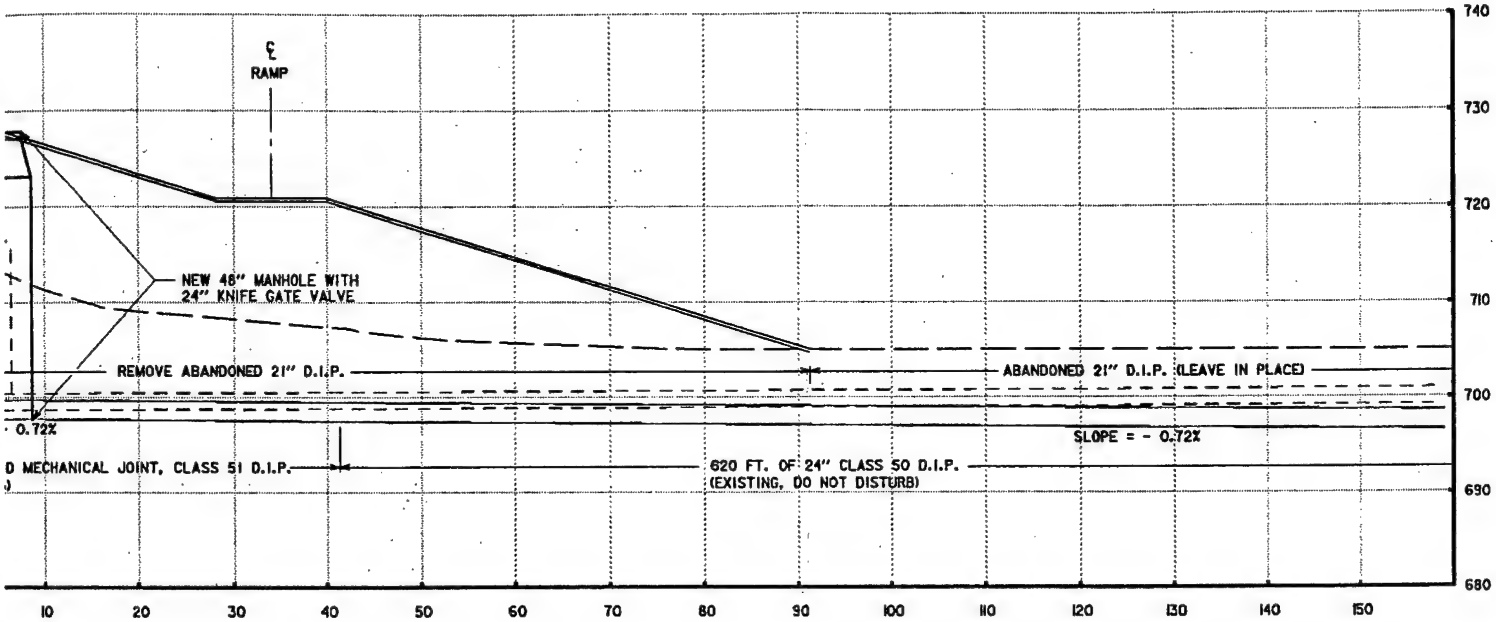
CAD FILE NAME: MNIOPATH.DGN
SPEC NO:
DRAWING NUMBER: MN34-CH-R-5/212
SHT 14 OF 31

2



PROFILE

TREATMENT PLANT OUTFALL PIPE
(LEVEE INTERSECTION AT STA. 32+00)



FALL PIPE
AT STA. 32+00)

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA

PROFILE
TREATMENT PLANT OUTFALL PIPE

ED-D: DESIGNED: R.J.M. CHECKED: J.J.G. DRAWN: R.J.M.
ED-GH: DESIGNED: CHECKED:
DATE: MARCH 1991

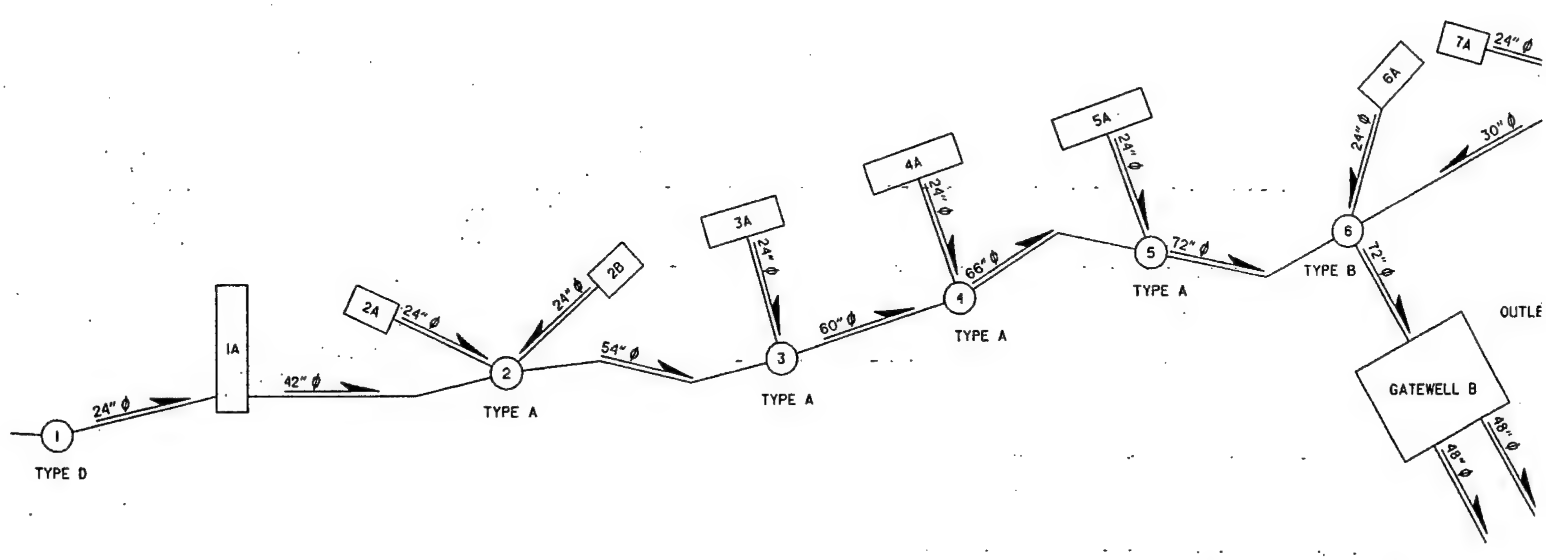
CAD FILE NAME: MNIOPOUTF.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/214
SHT 15 OF 31

2

MANHOLE SCHEDULE

STRUCTURE NO.	TYPE	STATION	CASTING RIM ELEVATION	ELEVATION A	RISER DIA.	BARREL DIA.	SLAB DIA.	H	W	INTERCEPTOR PIPE A INVERT	INTERCEPTOR PIPE A DIA.	INTERCEPTOR PIPE B INVERT	INTERCEPTOR PIPE B DIA.	OUTLET PIPE C INVERT	OUTLET PIPE C DIA.	INLET PIPE D INVERT	INLET PIPE D DIA.	INLET PIPE E INVERT	INLET PIPE E DI
MH-1	D	--	712.8	701.7	--	48"	85"	--	--	709.18	24"	701.95	24"	--	--	--	--	--	-
MH-2	A	71+15	710.0	697.91	48"	--	--	5'-6"	12'-0"	--	42"	--	54"	--	--	705.73	24"	705.73	24
MH-3	A	67+05	710.0	696.62	48"	--	--	4'-3"	10'-6"	--	54"	--	60"	--	--	705.73	24"	--	-
MH-4	A	63+03	710.0	695.34	48"	--	--	4'-8"	10'-8"	--	60"	--	66"	--	--	705.73	24"	--	-
MH-5	A	59+51	710.0	694.17	48"	--	--	--	--	--	66"	--	72"	--	--	705.73	24"	--	-
MH-6	B	55+88	714.0	692.92	48"	--	--	--	--	697.00	30"	693.50	72"	693.50	72"	709.73	24"	--	-
MH-7	C	53+94	711.0	697.11	48"	60"	92"	--	--	697.40	30"	697.40	30"	--	--	706.73	24"	706.73	24
MH-8	C	51+85	710.0	696.34	48"	60"	120"	--	--	696.99	30"	696.67	36"	--	--	705.73	24"	--	-
MH-9	A	49+94	709.0	695.31	48"	--	--	3'-8"	10'-0"	--	36"	--	48"	--	--	704.73	24"	--	-
MH-10	B	47+95	710.3	693.50	72"	--	--	--	--	695.00	48"	694.82	48"	693.50	66"	702.51	36"	--	-
MH-11	A	43+75	708.0	695.62	48"	--	--	3'-8"	10'-0"	--	36"	--	48"	--	--	703.73	24"	--	-
MH-12	C	41+43	708.0	696.73	48"	60"	120"	--	--	698.06	24"	697.06	36"	--	--	703.73	24"	--	-
MH-13	D	38+36	709.0	698.31	--	48"	100"	--	--	699.06	18"	698.56	24"	--	--	704.73	24"	704.73	24
MH-14	D	36+38	710.0	699.23	--	48"	92"	--	--	--	--	699.44	18"	--	--	--	--	--	-

INTERCEPTOR PIPE - CLASS III
INLET PIPE - CLASS II
OUTLET PIPE - SEE OUTLET PROFILES



GRAVITY STORM DRAINAGE SYSTEM

SCALE: NONE

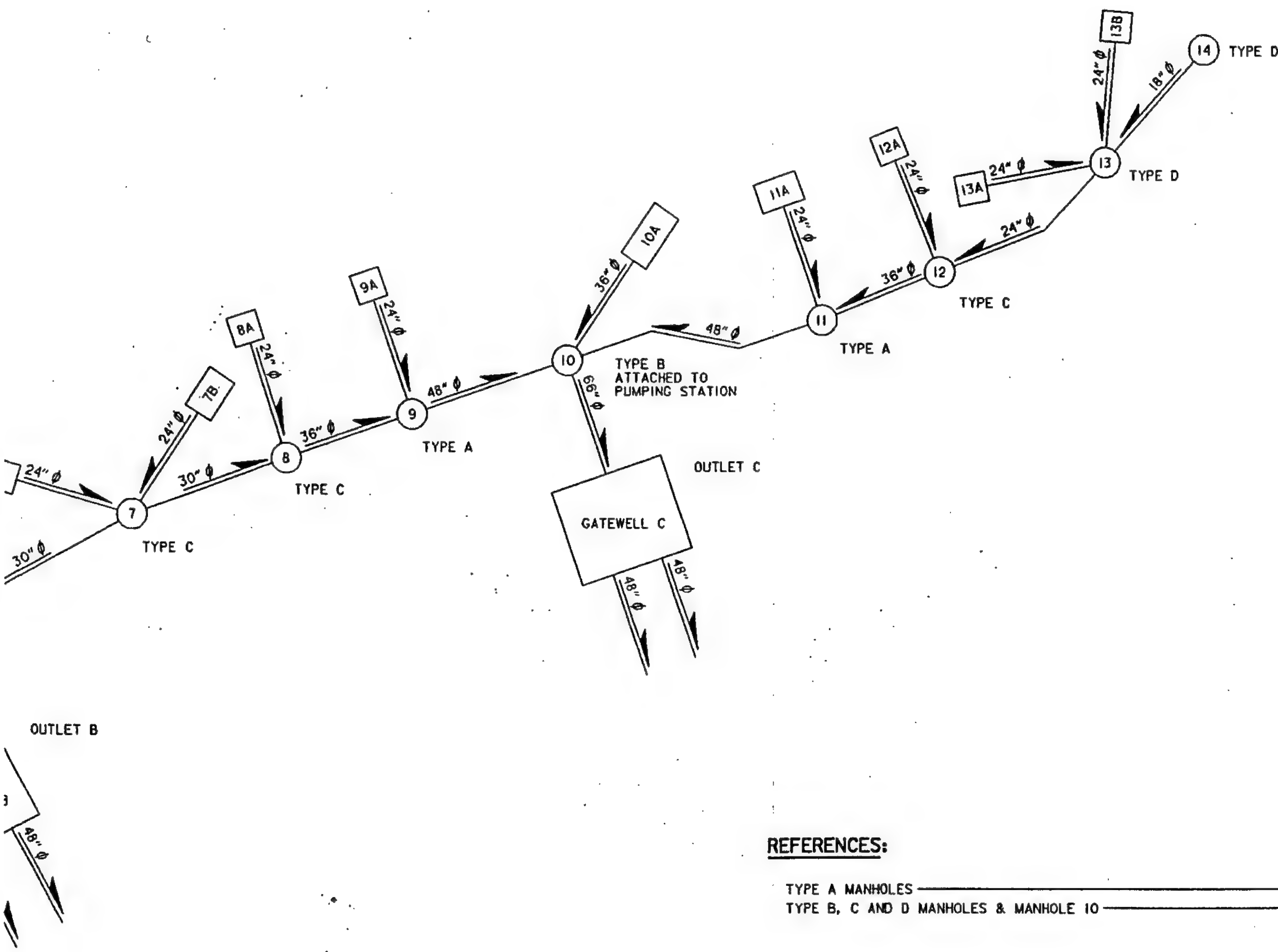
LEGEND:

(4) MANHOLE

[4A] INLET

—— R.C.P.

PIPE E		ANGLE (DEGREES•)			STRUCTURE NO.	REMARKS
ERT.	DIA.	α	β	γ		
--	--	197	--	--	MH-1	
5.73	24"	--	37	106	MH-2	INCREASER AT PIPE A
--	--	--	90	--	MH-3	INCREASER AT PIPE A
--	--	--	90	--	MH-4	INCREASER AT PIPE A
--	--	--	90	--	MH-5	INCREASER AT PIPE A - NO ARCH
--	--	--	138	--	MH-6	
5.73	24"	173	40	106	MH-7	
--	--	178	92	--	MH-8	
--	--	--	90	--	MH-9	INCREASER AT PIPE A
--	--	--	162	--	MH-10	
--	--	--	90	--	MH-11	INCREASER AT PIPE A
--	--	179	90	--	MH-12	
4.73	24"	180	37	106	MH-13	
--	--	--	--	--	MH-14	



REFERENCES:

TYPE A MANHOLES ———— 5/216
TYPE B, C AND D MANHOLES & MANHOLE 10 ———— 5/217

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

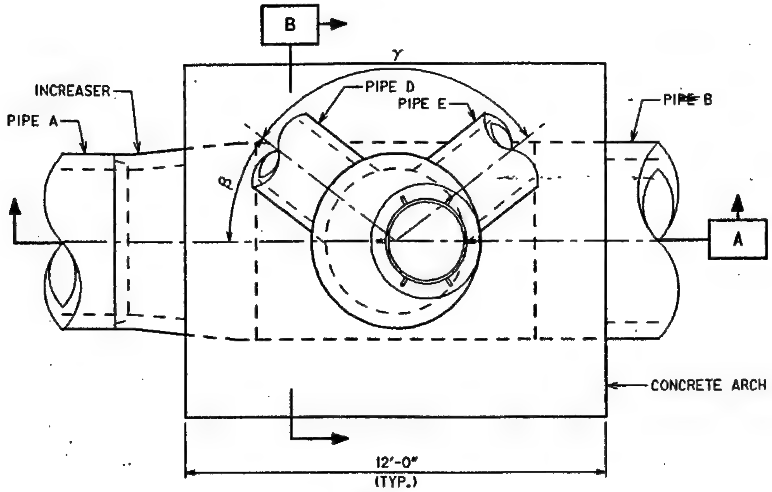
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
INTERIOR DRAINAGE
MANHOLES AND INLETS
MANHOLE SCHEDULE & GRAVITY STORM DRAINAGE SYSTEM

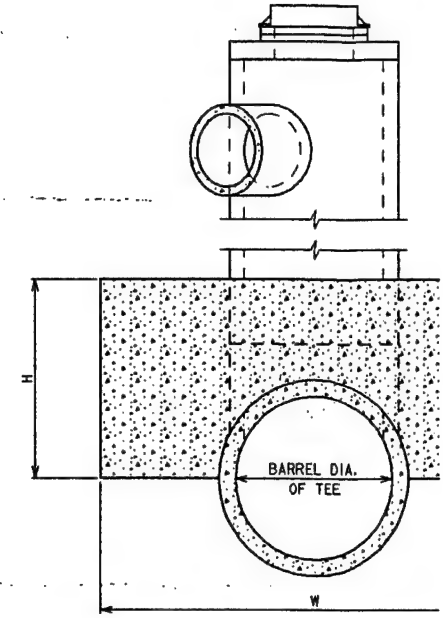
ED-D DESIGNED: NRH
CHECKED: GRS
DRAWN: LKT
ED-GH DESIGNED:
CHECKED:
DATE: MARCH 1991

CAD FILE NAME: NCSDR215.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/215
SHT 16 OF 31

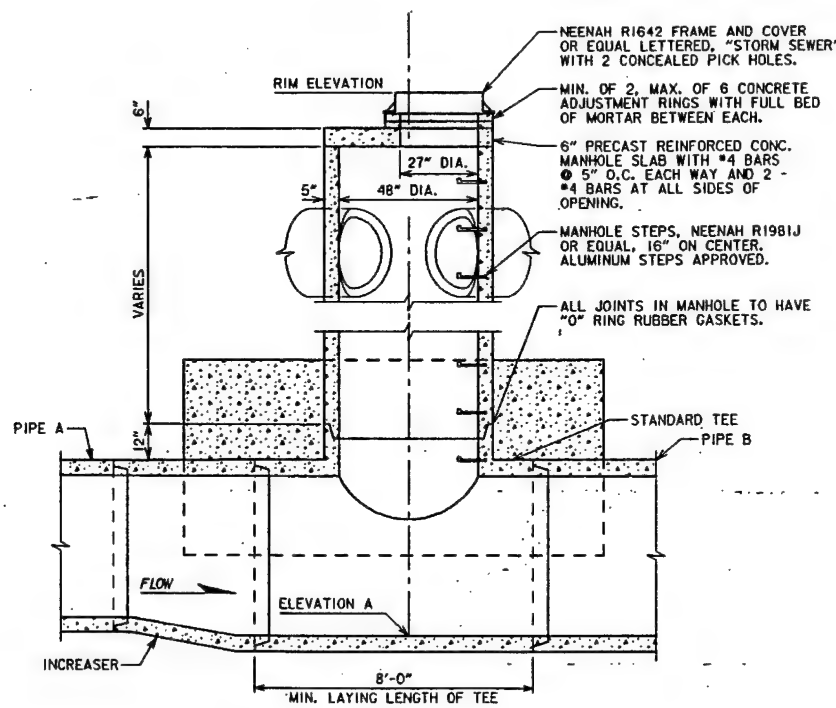
2



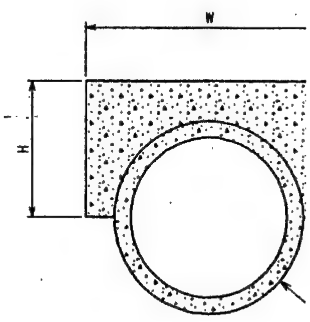
PLAN
TYPE A MANHOLE
SCALE: 3/8" = 1'-0"



SECTION
TYPE A MANHOLE
SCALE: 3/8"=1'-0"

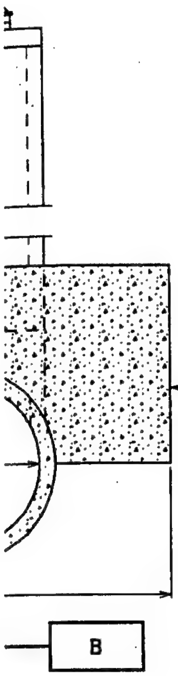


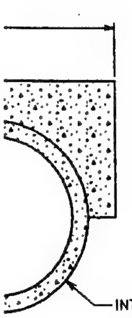
SECTION A
TYPE A MANHOLE
SCALE: 3/8"=1'-0"



TYPICAL SECTION
R.C.P. CONCRETE ARCH
SCALE: 3/8" = 1'-0"

INTERCEPTOR BETWEEN MANHOLES	W
1 - 2	6'-0"
2 - 3	7'-0"





SECTION
:ETE ARCH
' = 1'-0"

W	H
'-0"	3'-0"
'-0"	3'-10"

REFERENCES:

MANHOLE SCHEDULE AND SEQUENCE —————— 5/215

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

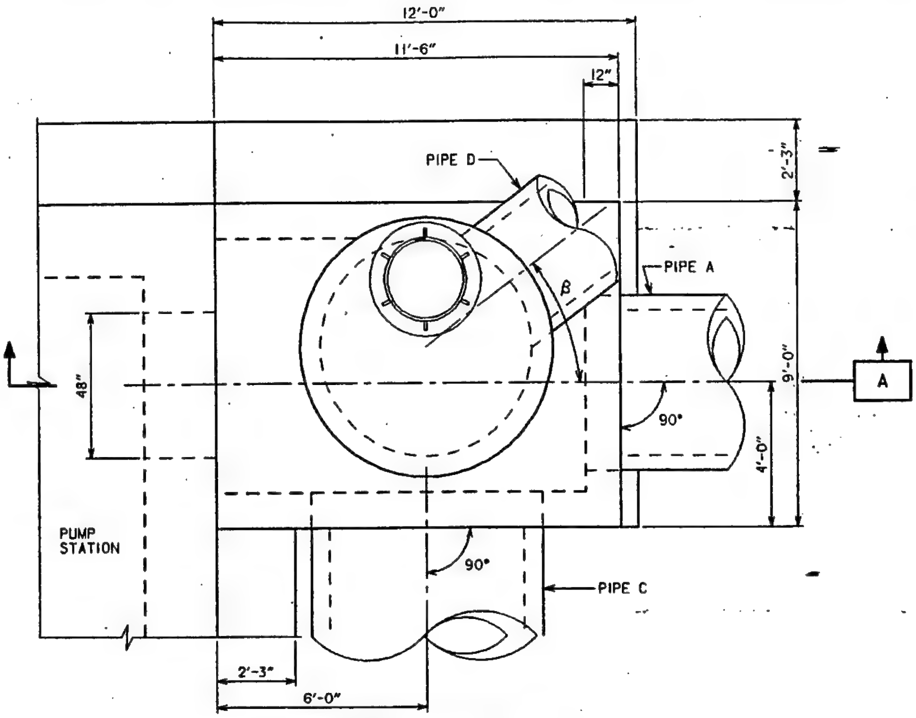
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
INTERIOR DRAINAGE
MANHOLE PLAN AND SECTIONS
TYPE A MANHOLE AND R.C.P. CONCRETE ARCH

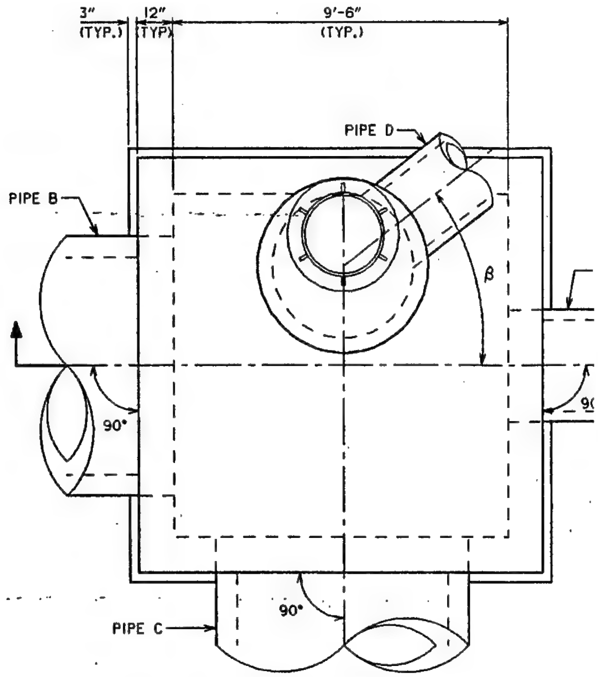
ED-D DESIGNED: NRH
CHECKED: GRS
DRAWN: LKT
ED-GH DESIGNED:
CHECKED:
DATE: MARCH 1991

CAD FILE NAME: NCSPR216.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/216
SHT 17 OF 31

2

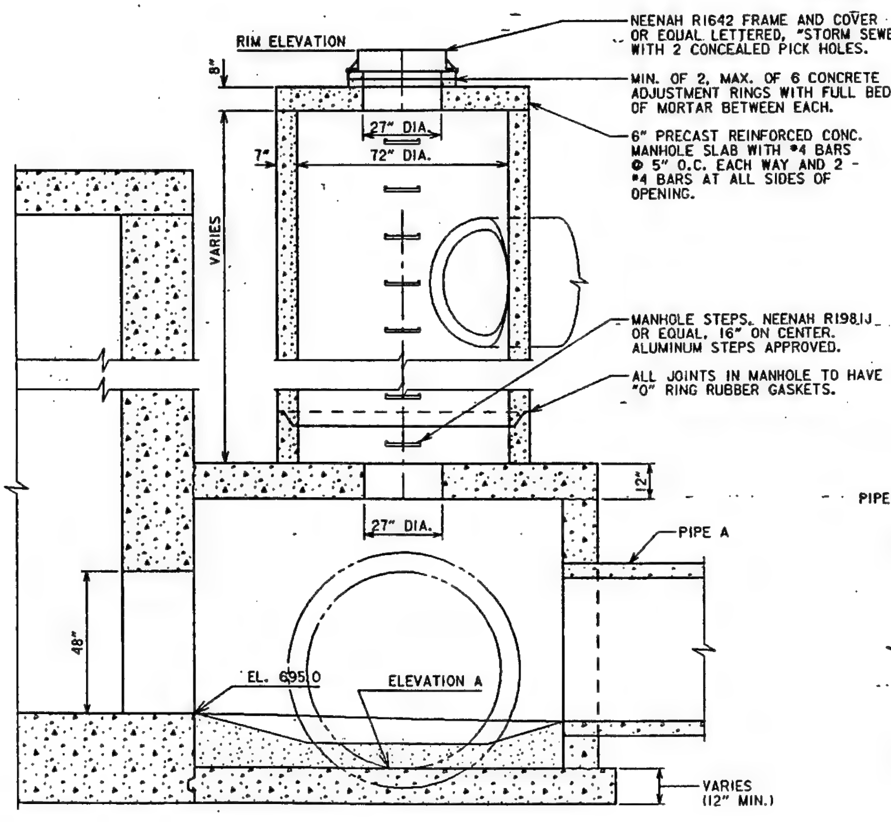


MANHOLE 10 (OUTLET C)



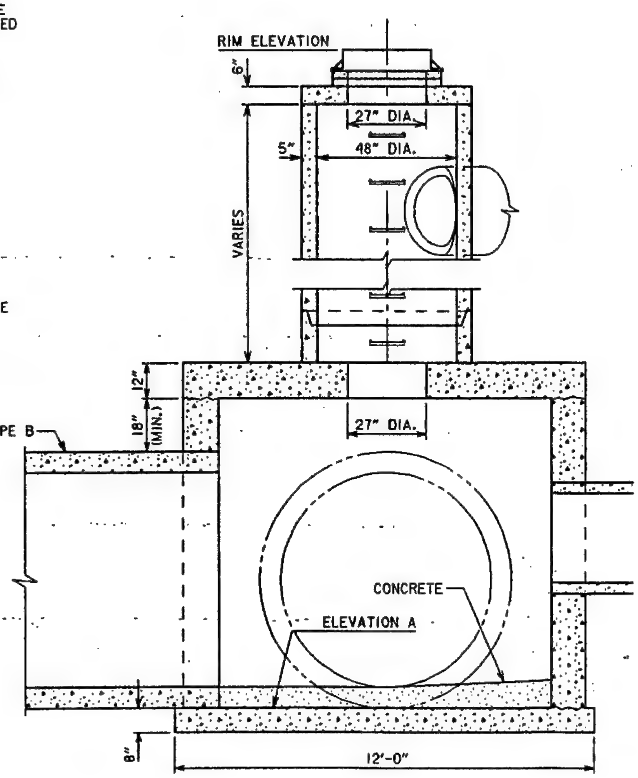
MANHOLE 6 (OUTLET B)

PLAN
TYPE B MANHOLES
SCALE: 3/8" = 1'-0"



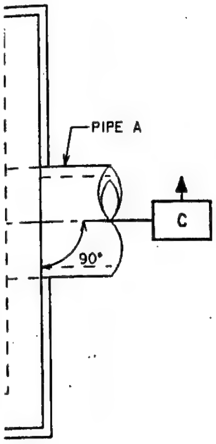
SECTION
MANHOLE 10 (OUTLET C)
SCALE: 3/8"=1'-0"

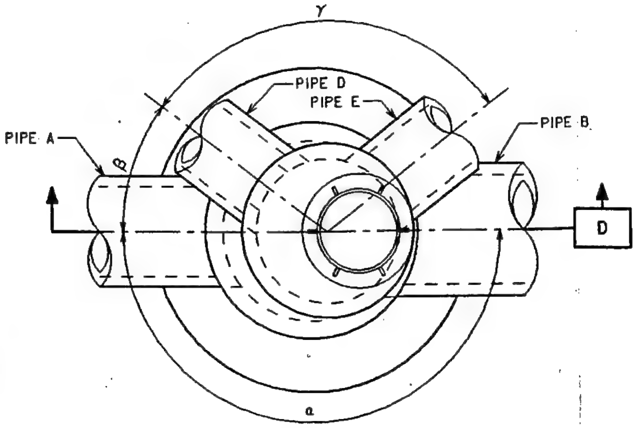
A



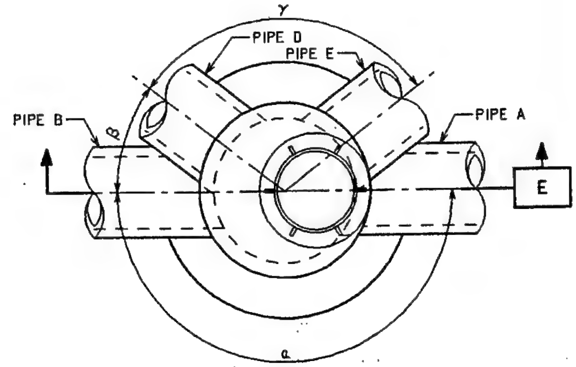
SECTION
MANHOLE 6 (OUTLET B)
SCALE: 3/8"=1'-0"

C

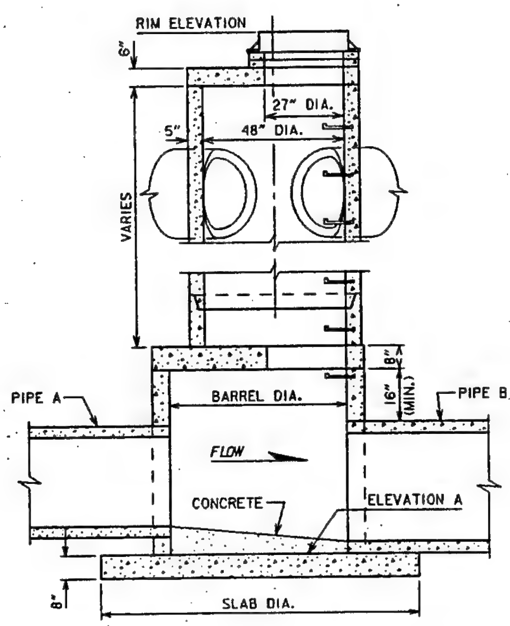




PLAN
TYPE C MANHOLE
SCALE: 3/8" = 1'-0"

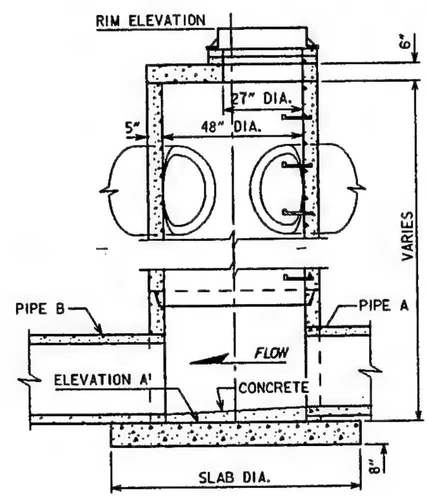


PLAN
TYPE D MANHOLE
SCALE: 3/8" = 1'-0"



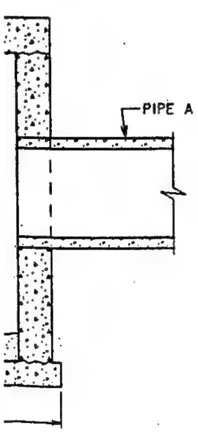
SECTION
TYPE C MANHOLE
SCALE: 3/8"=1'-0"

D



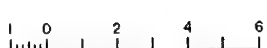
SECTION
TYPE D MANHOLE
SCALE: 3/8"=1'-0"

E



REFERENCES:

MANHOLE SCHEDULE AND SEQUENCE ———— 5/215



2

SYMBOL	DESCRIPTION	DATE	APPROVAL

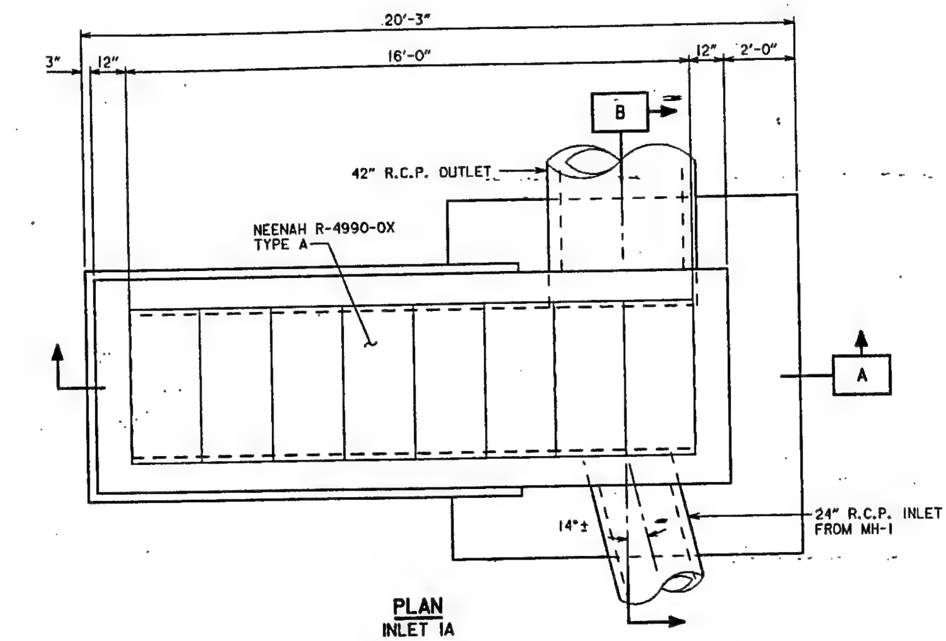
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

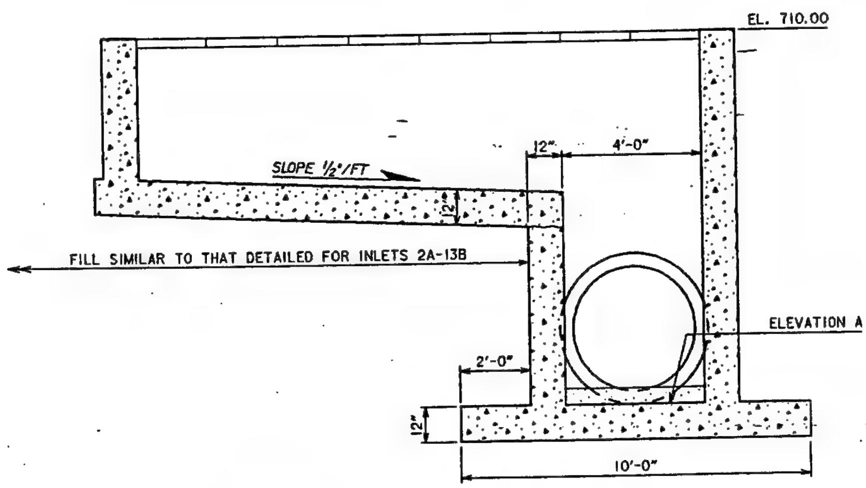
ED-D DESIGNED: NRH
CHECKED: GRS
DRAWN: LKT
ED-GH DESIGNED:
CHECKED:
DATE: MARCH 1991

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
INTERIOR DRAINAGE
MANHOLE PLANS AND SECTIONS
TYPE B, C, AND D

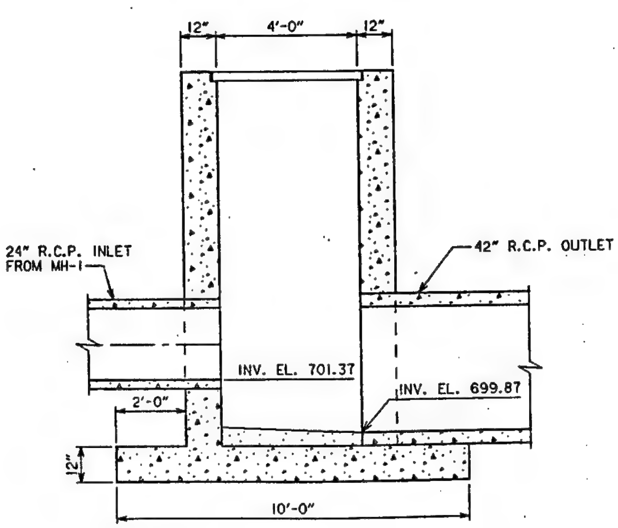
CAD FILE NAME: NCSPR217.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/217
SHT 18 OF 31



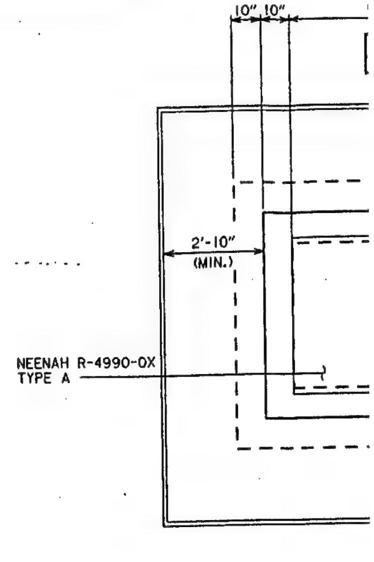
PLAN
INLET 1A
SCALE: 3/8" = 1'-0"



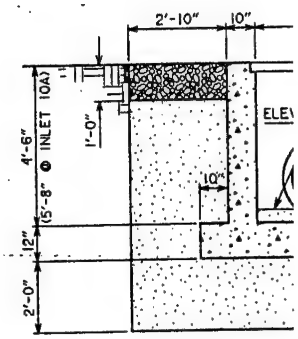
SECTION A
INLET 1A
SCALE: 3/8"=1'-0"



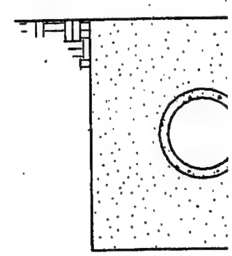
SECTION B
INLET 1A
SCALE: 3/8"=1'-0"



INLE
SCAL



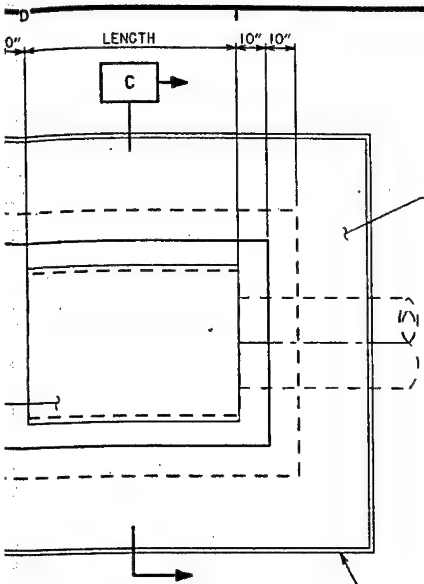
SECTION
INLETS 2A-13B
SCALE: 3/8"=1'-0"



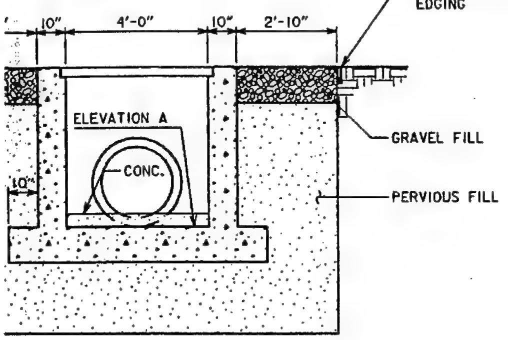
TYPICAL SE
FILL AROUND
INLETS 1A
SCALE: 3/8" =

INLET SCHEDULE

STRUCTURE NO.	TOP OF GRATING EL.	ELEVATION A	OUTLET PIPE INVERT EL.	OUTLET PIPE DIAMETER	LENGTH
INLET 1A	710.0	699.49	699.87	42"	16'
INLET 2A	710.0	705.50	705.75	24"	6'
INLET 2B	710.0	705.50	705.75	24"	6'
INLET 3A	710.0	705.50	705.75	24"	10'
INLET 4A	710.0	705.50	705.75	24"	12'
INLET 5A	710.0	705.50	705.75	24"	12'
INLET 6A	714.0	709.50	709.75	24"	8'
INLET 7A	711.0	706.50	706.75	24"	6'
INLET 7B	711.0	706.50	706.75	24"	6'
INLET 8A	710.0	705.50	705.75	24"	4'
INLET 9A	709.0	704.50	704.75	24"	4'
INLET 10A	708.0	702.33	702.67	36"	8'
INLET 11A	708.0	703.50	703.75	24"	6'
INLET 12A	708.0	703.50	703.75	24"	4'
INLET 13A	709.0	704.50	704.75	24"	4'
INLET 13B	709.0	704.50	704.75	24"	4'

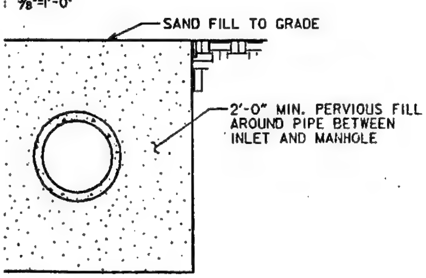


PLAN
INLETS 2A-13B
SCALE: 3/8" = 1'-0"

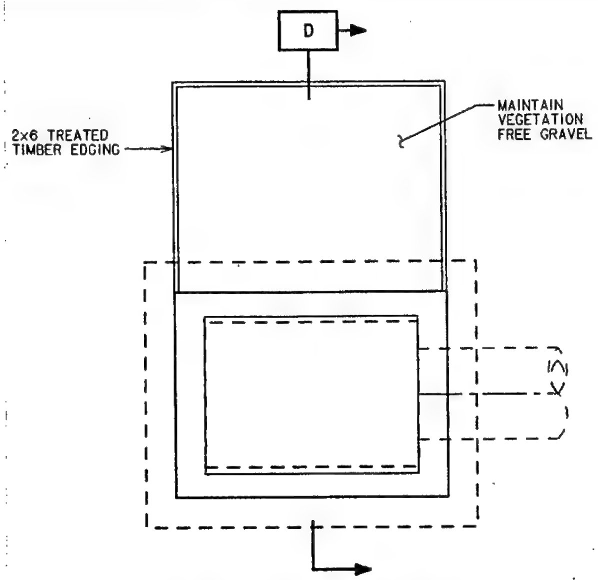


ION
S 2A-13B
: 3/8"=1'-0"

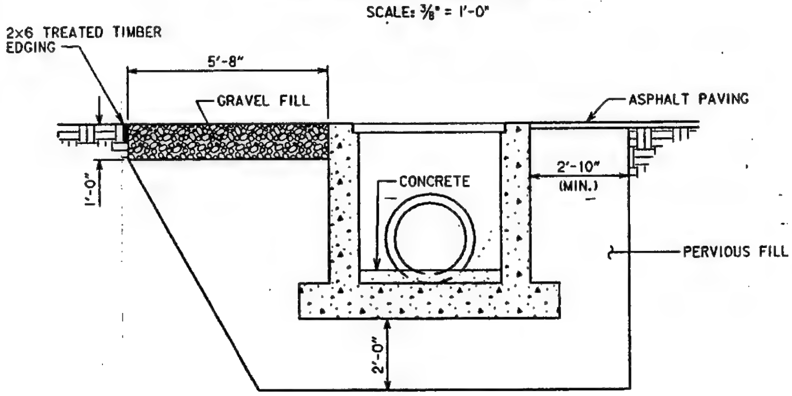
C



YPICAL SECTION
ILL AROUND PIPES
INLETS 1A-13B
SCALE: 3/8" = 1'-0"



PLAN
OPTIONAL FILL - INLETS 2A-13B
SCALE: 3/8" = 1'-0"



SECTION
OPTIONAL FILL - INLETS 2A-13B
SCALE: 3/8"=1'-0"

D

NOTE:

1. OPTIONAL FILL TO BE USED IF INLET IS LOCATED IN ASPHALT PAVED STREET.

SCHEDULE

LENGTH	REMARKS
16'	
6'	
6'	
10'	
12'	
12'	
8'	
6'	
6'	
4'	
4'	
8'	
6'	
4'	
4'	
4'	

0 2 4 6
SCALE: 3/8" = 1'-0"

2

SYMBOL	DESCRIPTION	DATE	APPROVAL

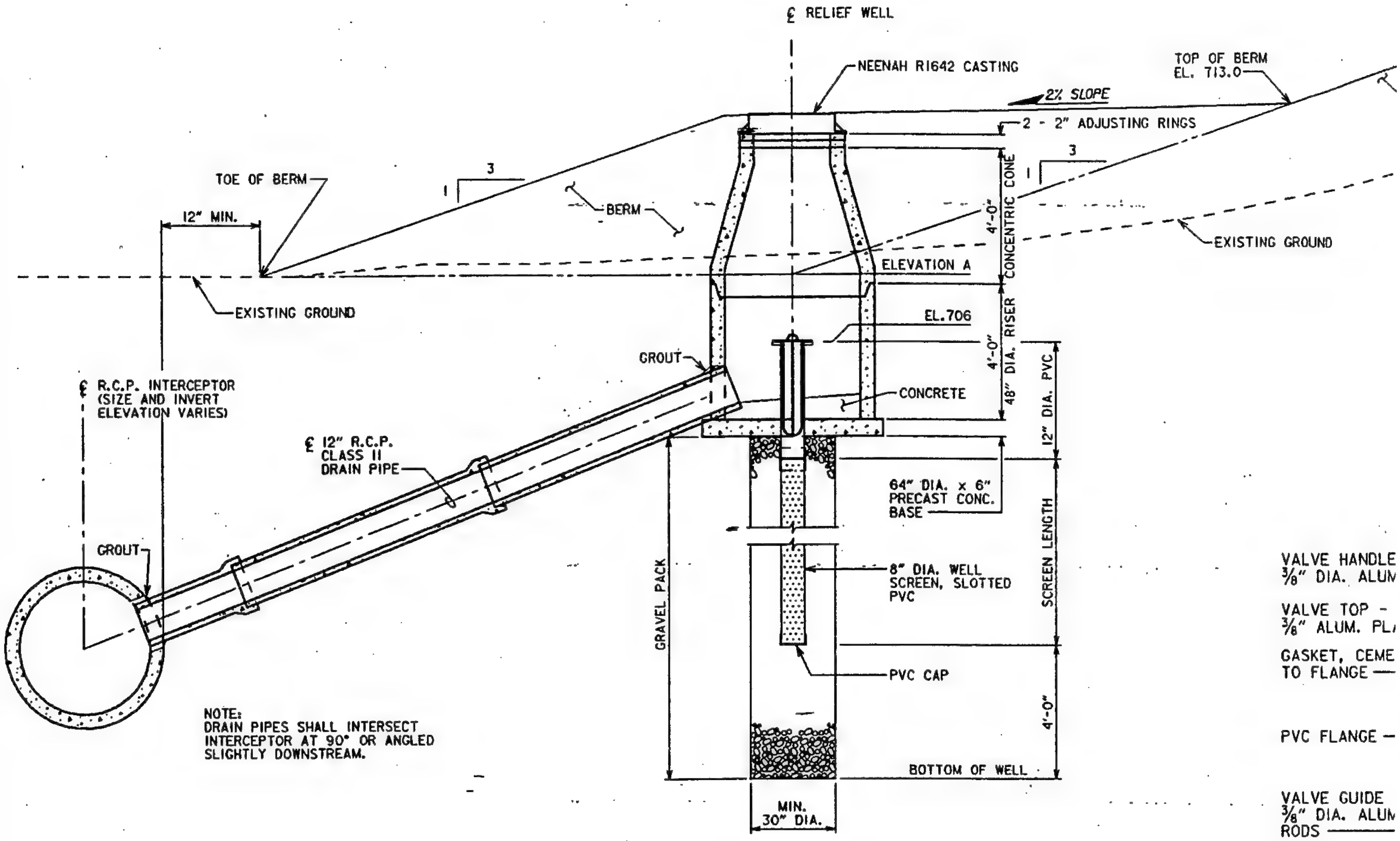
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
INTERIOR DRAINAGE
INLETS
PLANS, SECTIONS & SCHEDULE

ED-D	DESIGNED: NRH
	CHECKED: GRS
	DRAWN: LKT
ED-GH	DESIGNED: JRC
	CHECKED: JRC
	DATE: MARCH 1991

CAD FILE NAME: NCSPR218.DGN
SPEC NO:
DRAWING NUMBER: MN34-CH-R-5/218
SHT 19 OF 31



TYPICAL SECTION
RELIEF WELL

1 0 2 4 6
SCALE: 3/8" = 1'-0"

VALVE HANDLE
3/8" DIA. ALUN

VALVE TOP -
3/8" ALUM. PL

GASKET, CEME
TO FLANGE

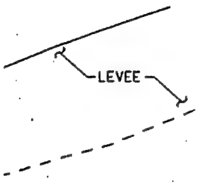
PVC FLANGE

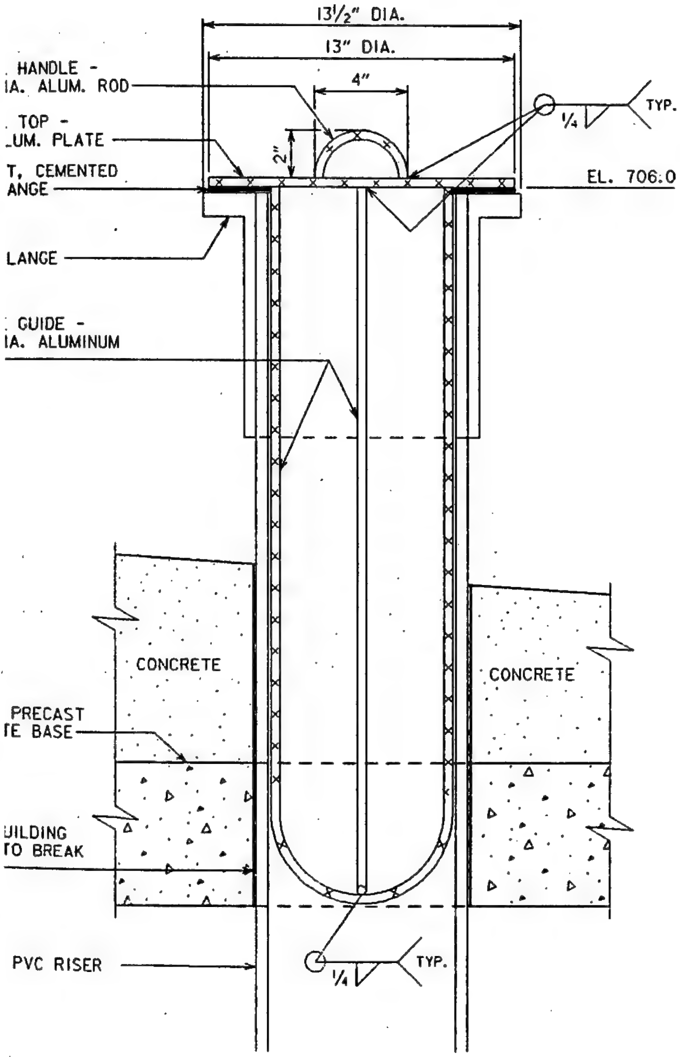
VALVE GUIDE
3/8" DIA. ALUN
RODS

TOP OF PRECAS
CONCRETE BASE

WRAP BUILDING
PAPER TO BREAI
BOND

8" DIA. PVC RI





TYPICAL SECTION
VALVE & RISER TOP
1" 0 4" 8"
SCALE: 3" = 1'-0"

RELIEF WELL SCHEDULE				
WELL NO.	LEVEE STA.	ELEV. A	WELL SCREEN LENGTH (FT)	REMARKS
RW-1	60+66	709	10	
RW-2	59+40	709	38	
RW-3	59+00	709	38	
RW-4	58+20	709	38	
RW-5	57+40	709	38	
RW-6	56+60	709	38	
RW-7	55+80	709	39	
RW-8	54+66.5	709	39	
RW-9	53+92.5	709	39	
RW-10	53+18.5	709	39	
RW-11	52+44.5	709	39	
RW-12	51+70.5	709	48	
RW-13	51+03.5	709	48	
RW-14	50+36.5	709	48	
RW-15	49+69.5	709	48	
RW-16	49+02.5	709	48	
RW-17	48+35.5	709	60	
RW-18	47+89.5	709	60	
RW-19	47+43.5	708	60	
RW-20	46+97.5	708	60	
RW-21	46+51.5	708	60	
RW-22	46+05.5	708	60	
RW-23	45+59.5	708	60	
RW-24	45+13.5	708	60	
RW-25	44+67.5	708	60	
RW-26	44+21.5	708	59	
RW-27	43+49.7	708	59	
RW-28	42+77.5	708	59	
RW-29	42+05.5	708	59	
RW-30	41+33.5	708	59	
RW-31	40+61.5	708	59	
RW-32	39+89.5	710	59	
RW-33	38+87.5	710	59	
RW-34	37+85.5	710	59	
RW-35	36+83.5	710	59	
RW-36	35+81.5	710	59	–

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

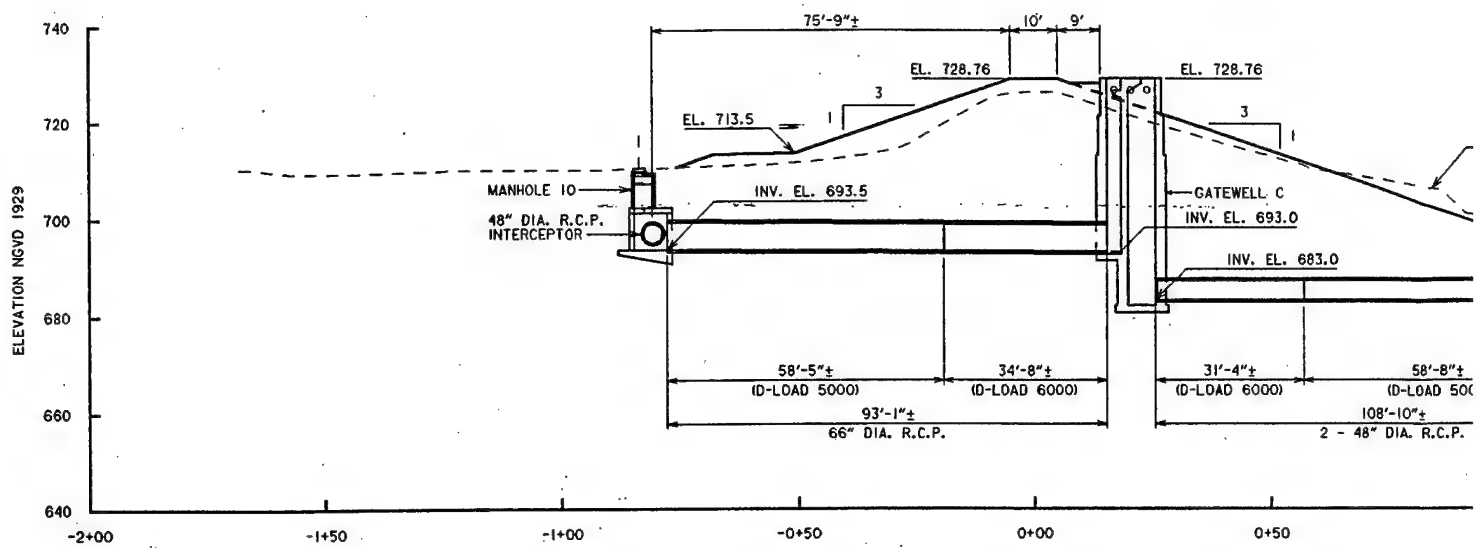
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
INTERIOR DRAINAGE
RELIEF WELLS
SECTIONS AND SCHEDULE

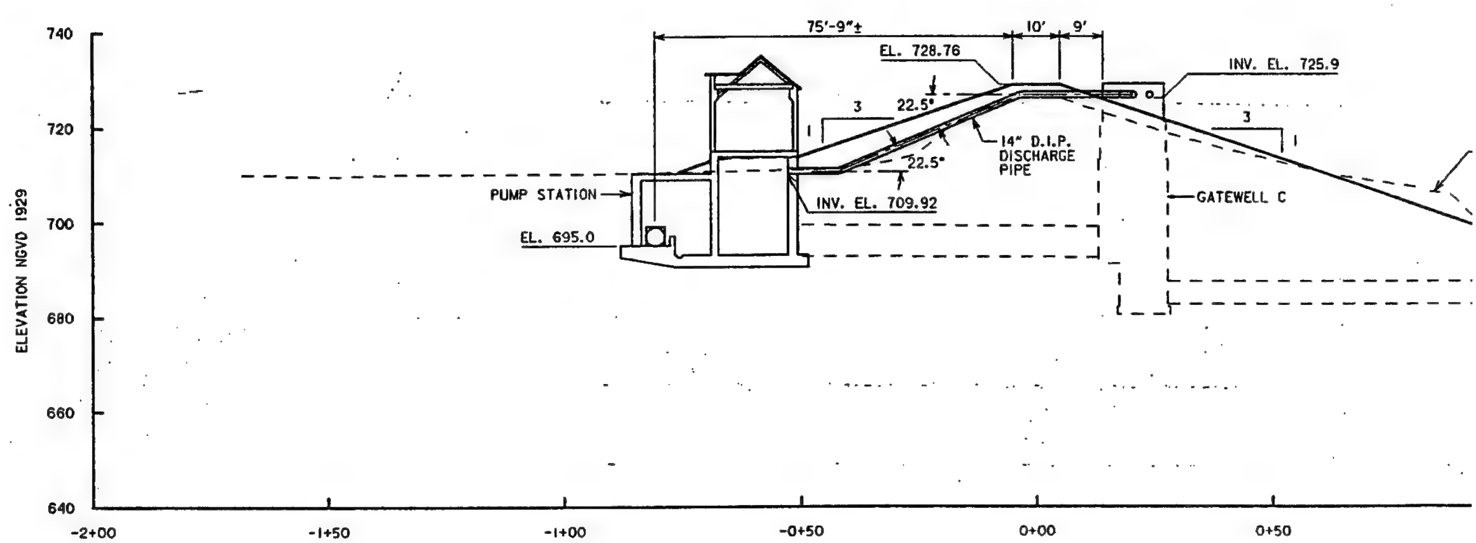
ED-D DESIGNED: GRS
CHECKED: GRS
DRAWN: LKT
ED-GH DESIGNED: JRC
CHECKED: JRC
DATE: MARCH 1991

CAD FILE NAME: NCSDR219.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/219
SHT 20 OF 31

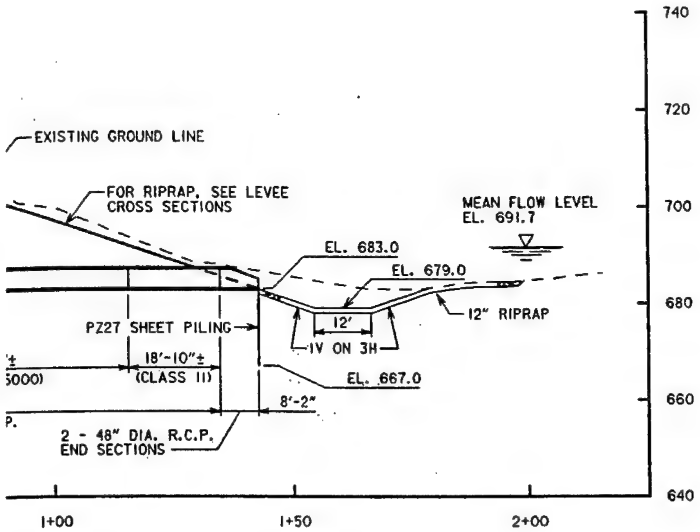
2

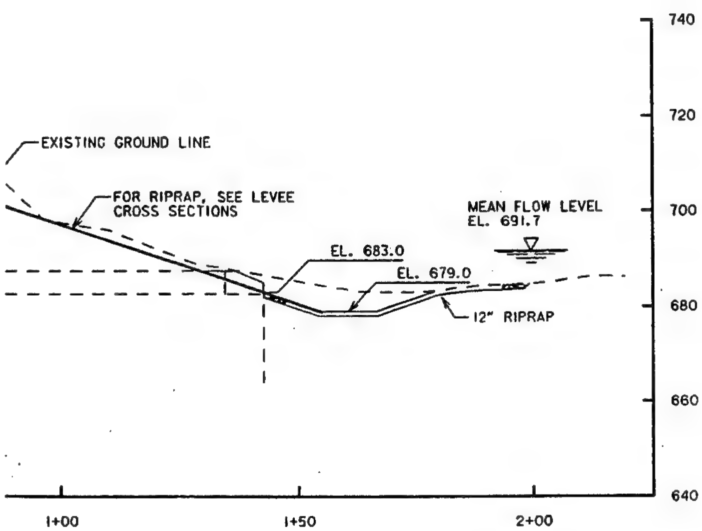


PROFILE | **A**
OUTLET C - STA. 47+94.6 | 5/224
SCALE: 1" = 20'-0"



PROFILE | **B**
STA. 48+11.6 | 5/224
SCALE: 1" = 20'-0"





SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

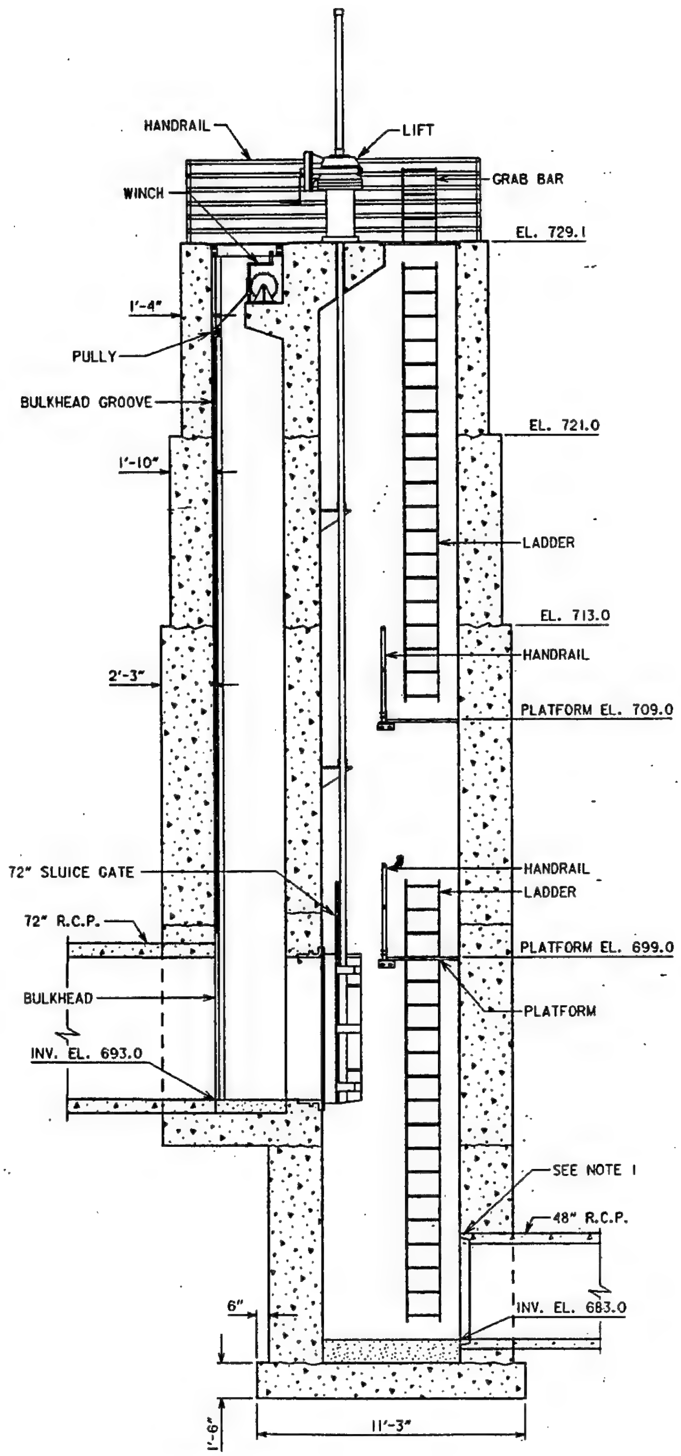
DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA

INTERIOR DRAINAGE
OUTLET C
PROFILES

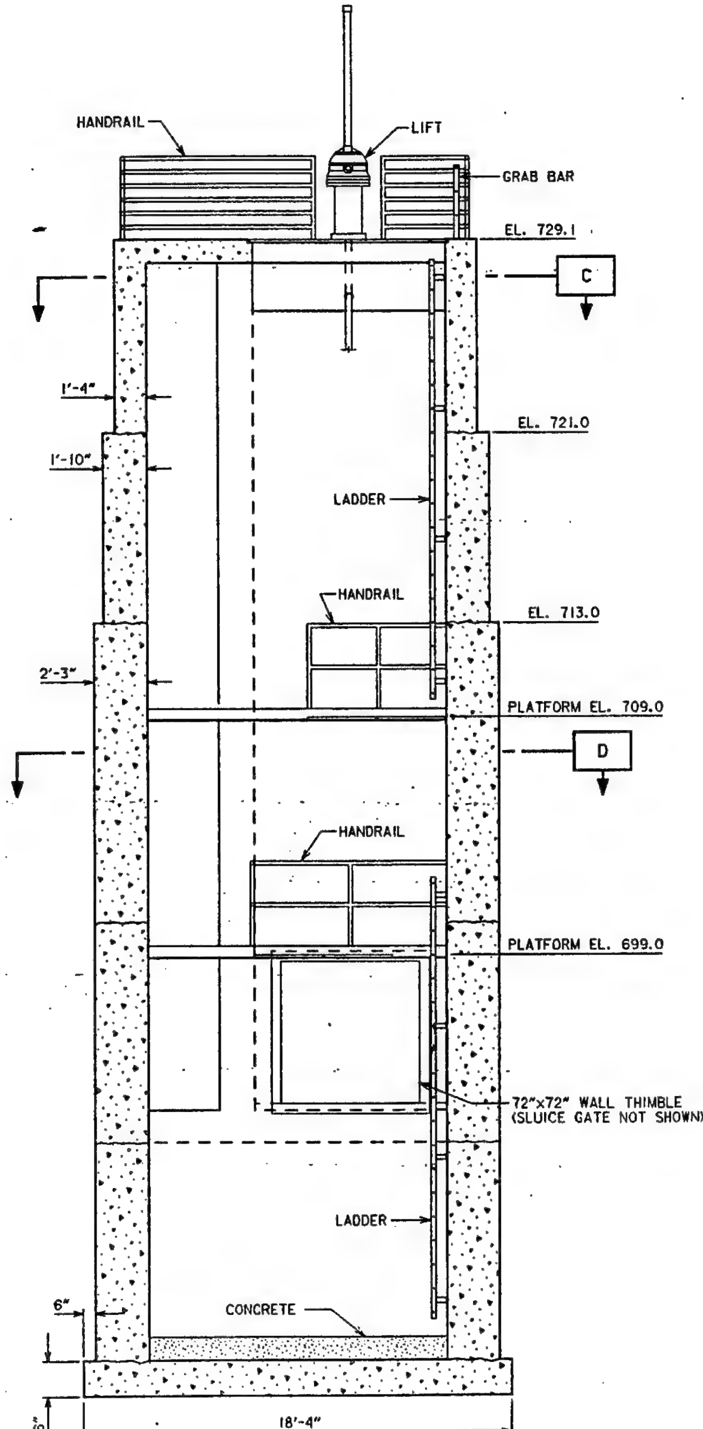
ED-D: DESIGNED: NRH; CHECKED: GRS; DRAWN: LKT
ED-GH: DESIGNED: JWM; CHECKED:
DATE: MARCH 1991

CAD FILE NAME: NCGIR220.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/220
SHT 21 OF 31

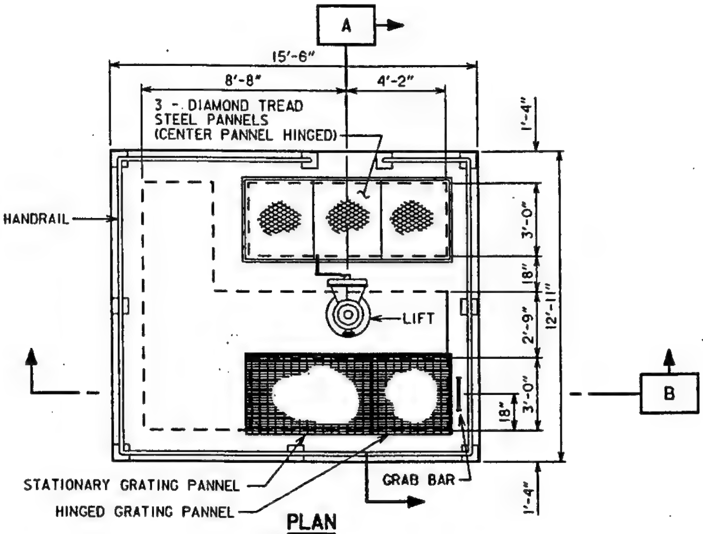
2



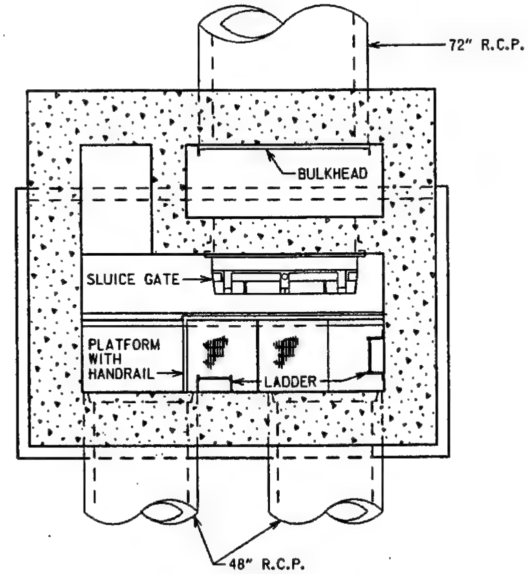
SECTION A
STA. 55+88.45
SCALE: 1/4"=1'-0"



SECTION B
SCALE: 1/4"=1'-0"

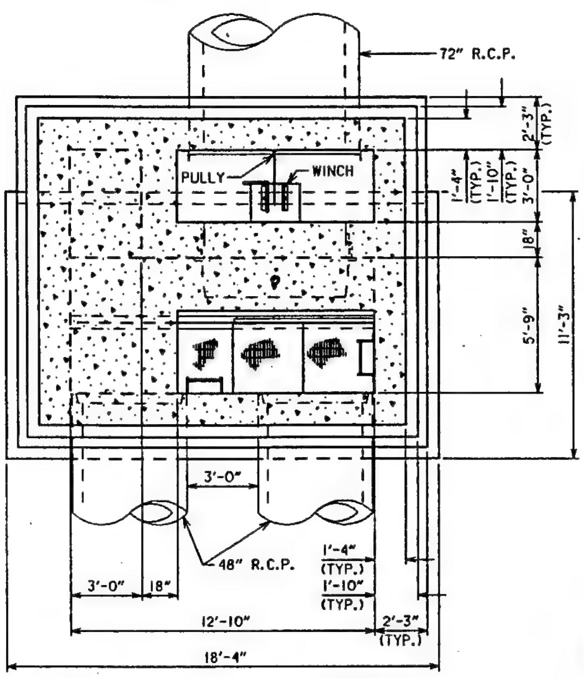


PLAN
TOP SLAB
SCALE: 1/4" = 1'-0"



SECTION D

SCALE: 1/4"=1'-0"



SECTION C

SCALE: 1/4"=1'-0"

NOTES:

1. FOR R.C.P. PROVIDE TONGUE AND GROVE JOINT, GROVE END AT THE OUTLET OF ALL CAST-IN-PLACE STRUCTURES. ALL OTHER R.C.P. JOINTS TO BE BELL AND SPIGOT. TYPE CX-4 O-RING RUBBER GASKET JOINT.

0 4 8
SCALE: 1/4" = 1'-0"

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

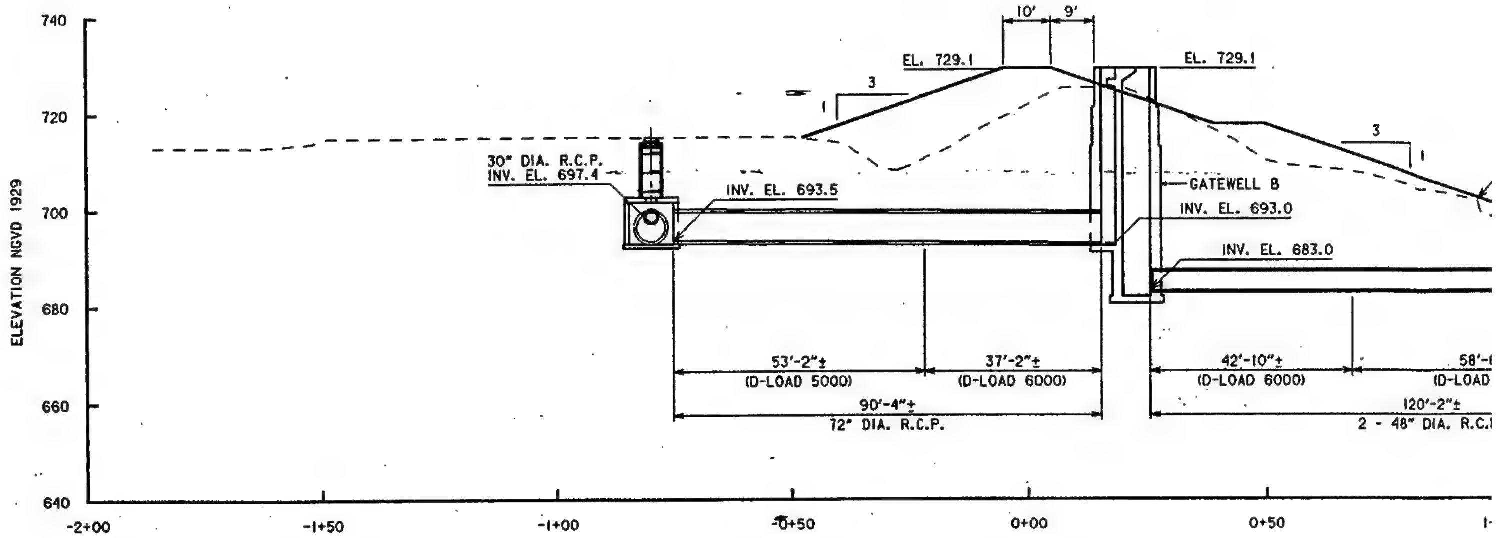
DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT — CHASKA, MINNESOTA
INTERIOR DRAINAGE
GATEWELL B
PLAN AND SECTIONS

ED-D	DESIGNED: GRS
	CHECKED: GRS
	DRAWN: LKT
ED-GH	DESIGNED:
	CHECKED:

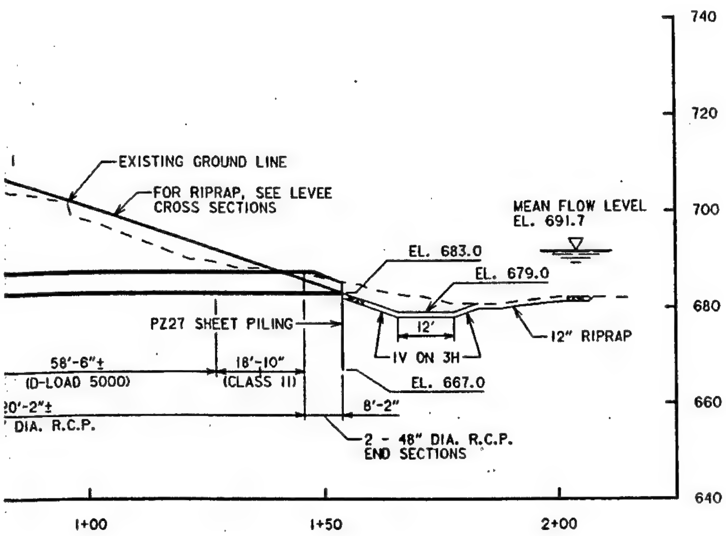
DATE: MARCH 1991

CAD FILE NAME: NCSPR222.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/222
SHT 23 OF 31

2



PROFILE
OUTLET B - STA. 55+88.45
SCALE: 1" = 20'-0"



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
DESIGN MEMORANDUM NO. 2
FLOOD CONTROL - MINNESOTA RIVER
CHASKA STAGE 4 CHASKA, MINNESOTA
INTERIOR DRAINAGE
OUTLET B
PROFILE

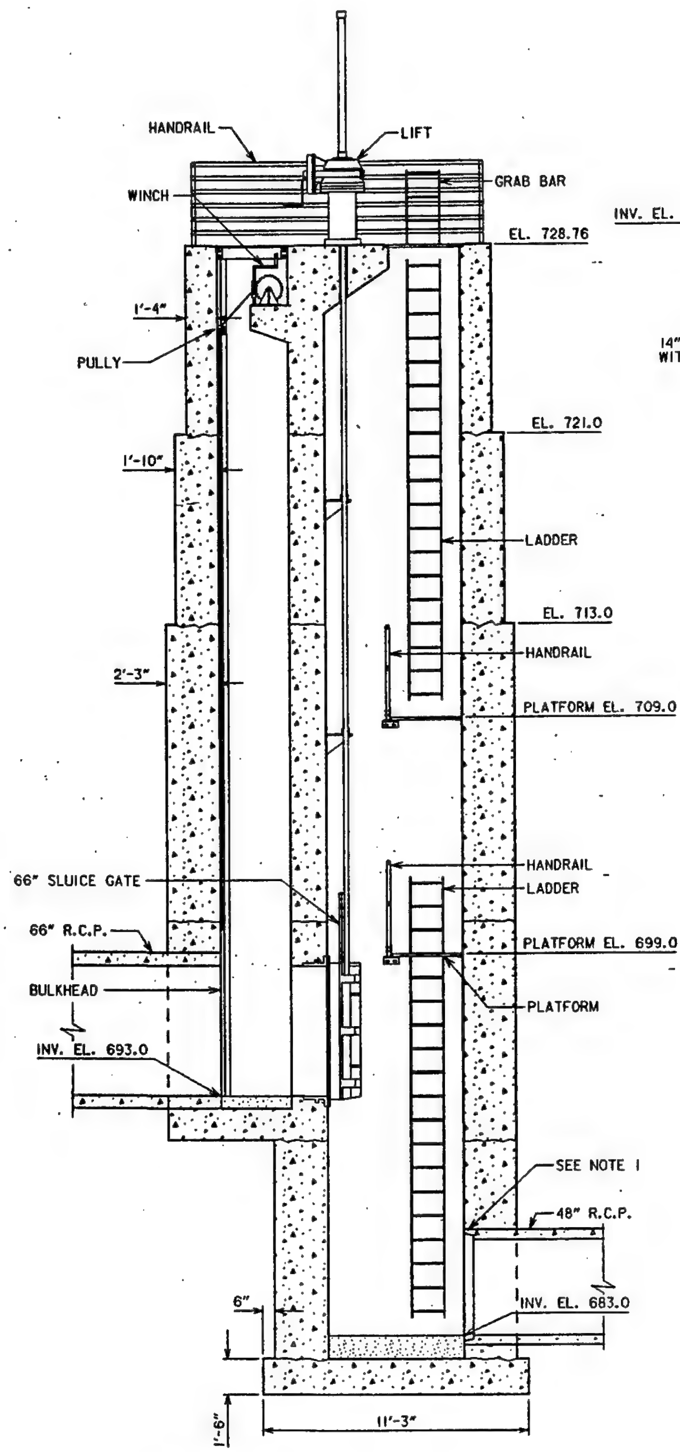
ED-D	DESIGNED:	GRS/NRH
ED-D	CHECKED:	GRS
ED-D	DRAWN:	LKT
ED-GH	DESIGNED:	
ED-GH	CHECKED:	
	DATE:	MARCH 1991

CAD FILE NAME: NCGIR221.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/221
SHT 22 OF 31

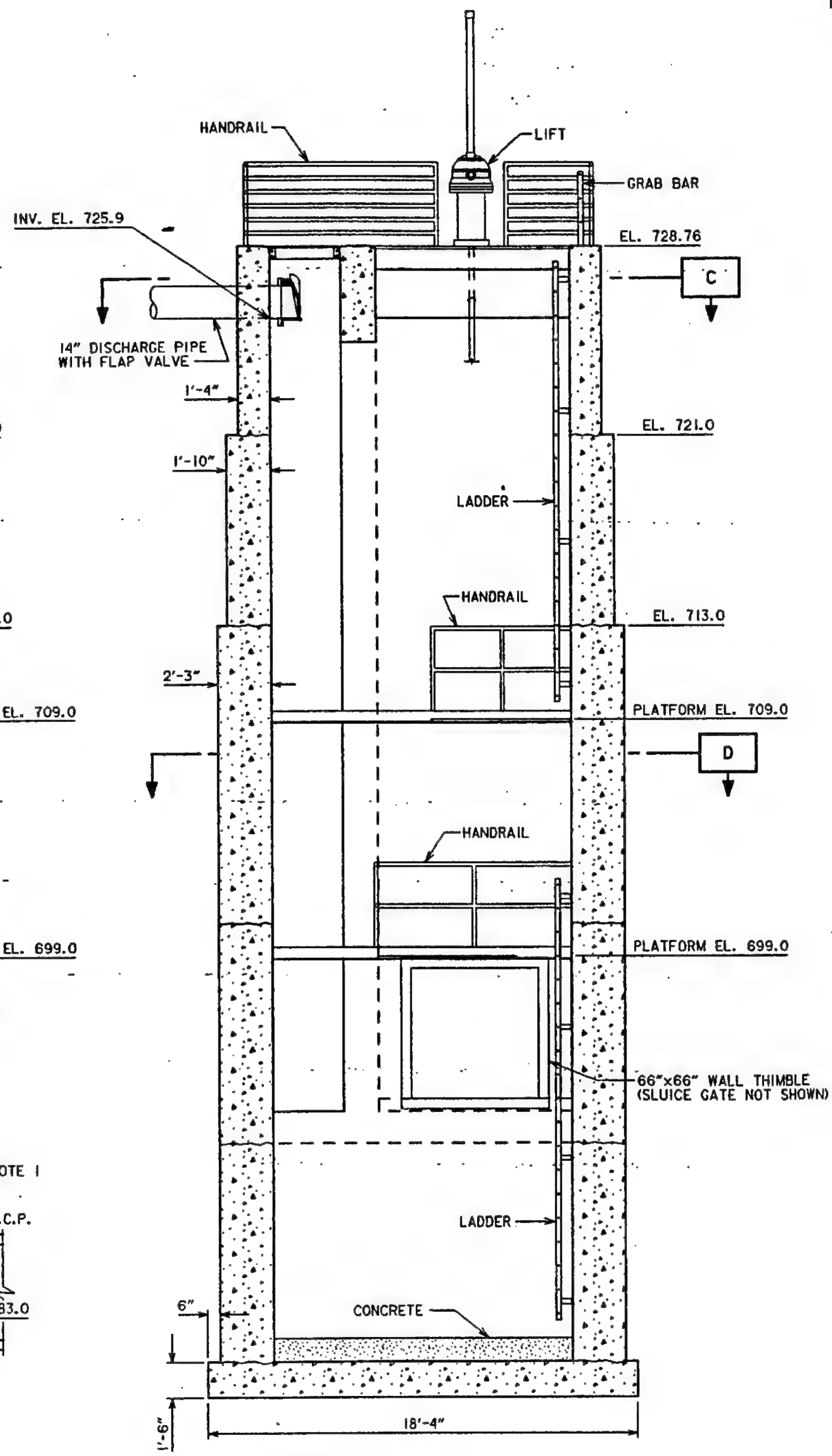
2

HANDR

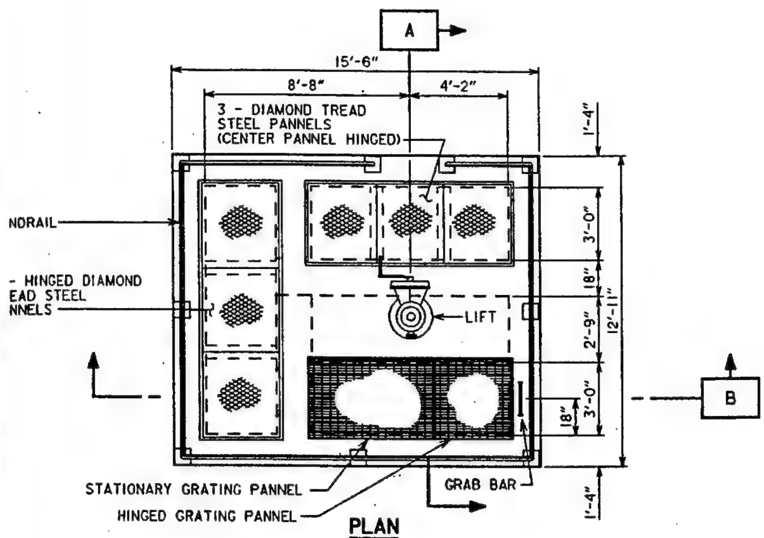
3 - H
TREAD
PANNE



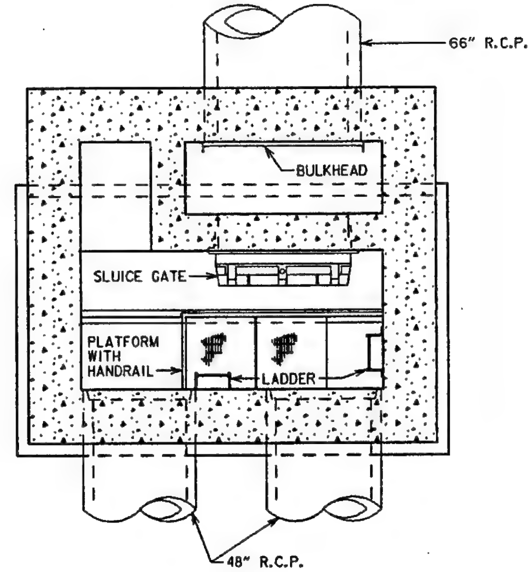
SECTION A
STA. 47+94.6
SCALE: 1/4"=1'-0"



SECTION B
SCALE: 1/4"=1'-0"

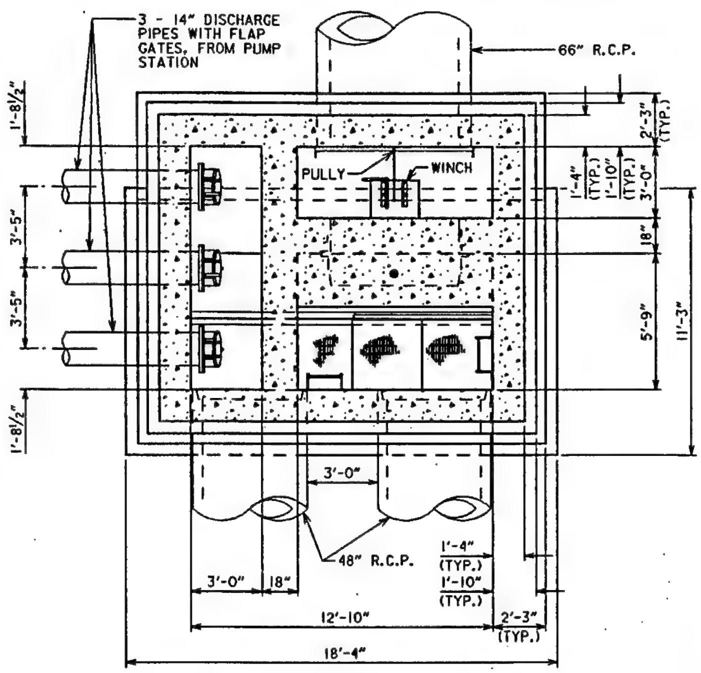


PLAN
TOP SLAB
SCALE: 1/4" = 1'-0"



SECTION D

SCALE: 1/4"=1'-0"



SECTION C

SCALE: 1/4"=1'-0"

NOTES:

1. FOR R.C.P. PROVIDE TONGUE AND GROVE JOINT, GROVE END AT THE OUTLET OF ALL CAST-IN-PLACE STRUCTURES. ALL OTHER R.C.P. JOINTS TO BE BELL AND SPIGOT. TYPE CX-4 O-RING RUBBER GASKET JOINT.

0 4 8
SCALE: 1/4" = 1'-0"

2

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

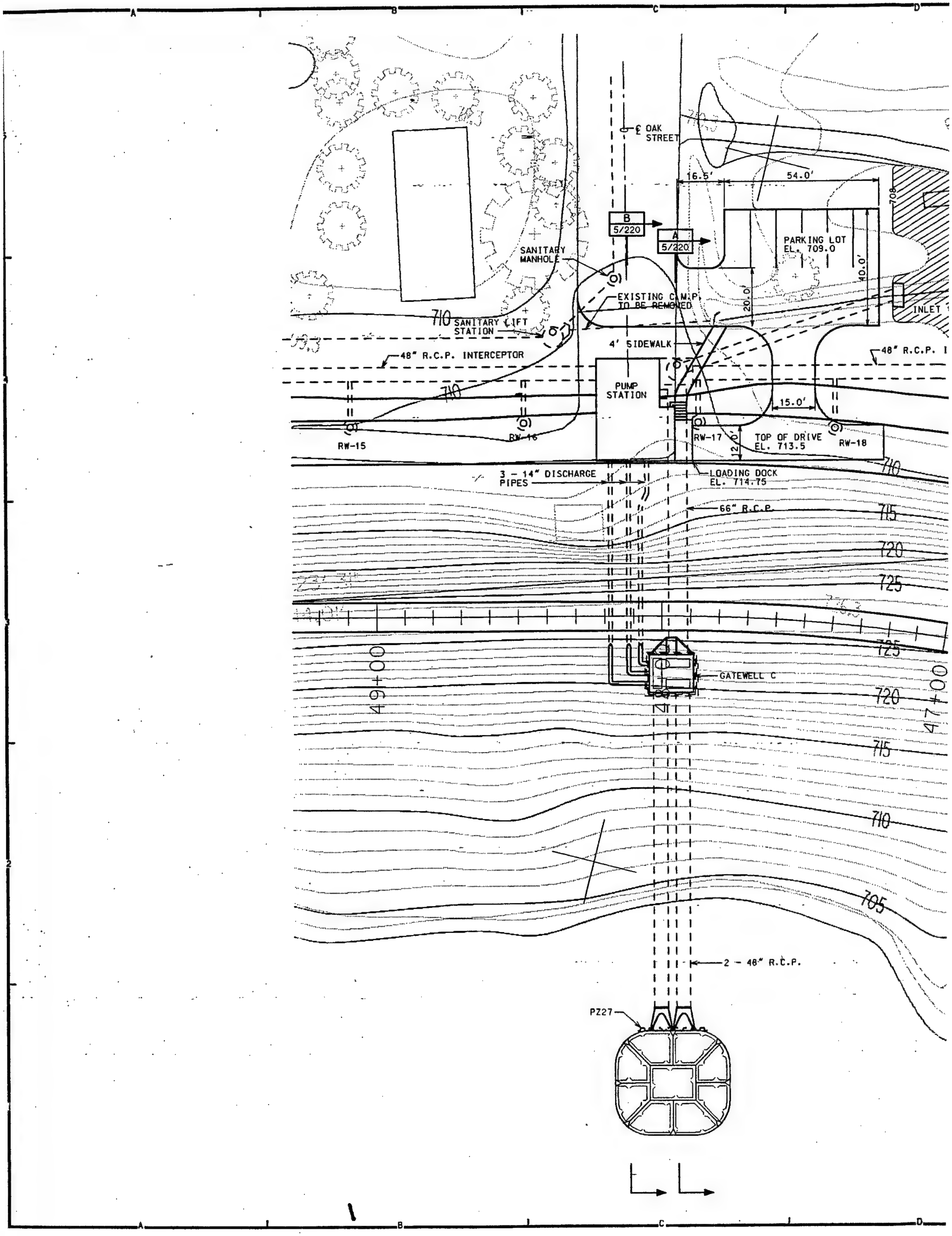
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
INTERIOR DRAINAGE
GATEWELL C
PLAN AND SECTIONS

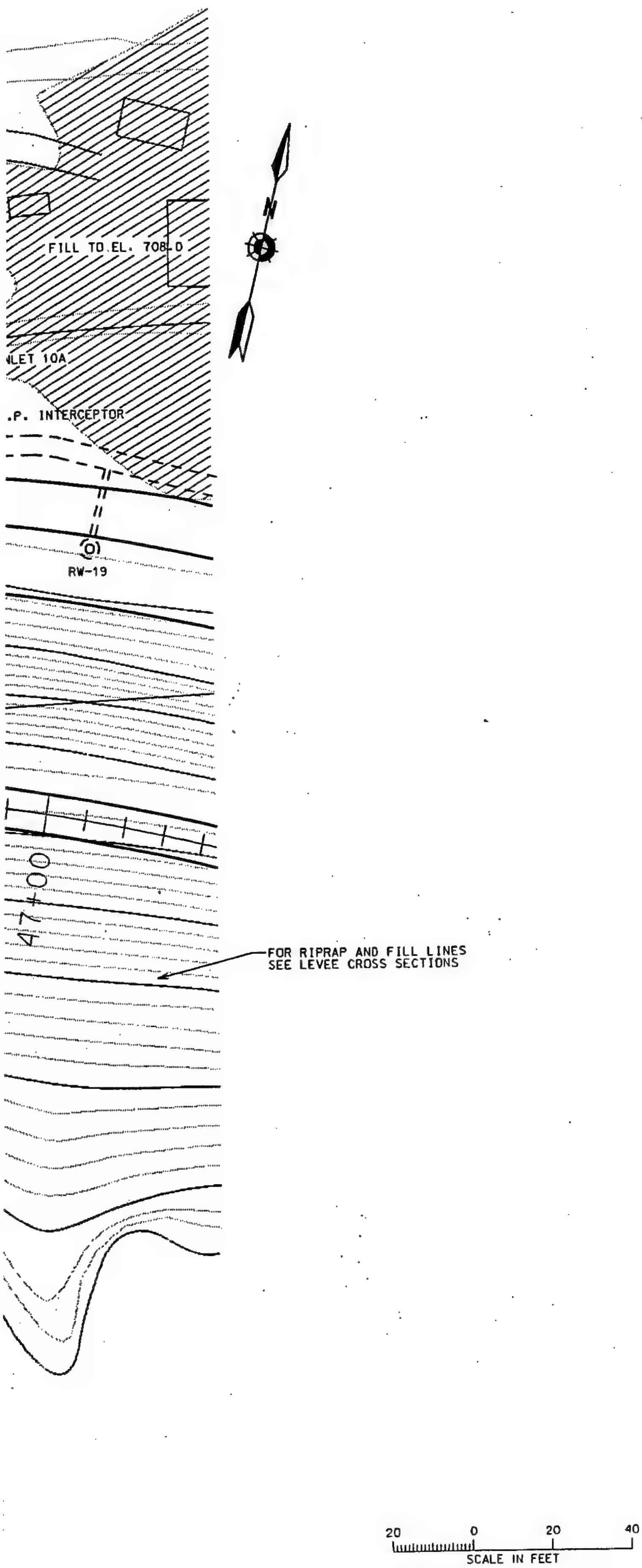
ED-D	DESIGNED:	GRS
ED-D	CHECKED:	GRS
ED-D	DRAWN:	LKT
ED-GH	DESIGNED:	
ED-GH	CHECKED:	

DATE: MARCH 1991

CAD FILE NAME: NCSPR223.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/223
SHT 24 OF 31



℄ OAK STREET
16.5'
54.0'
708
B 5/220
A 5/220
PARKING LOT EL. 709.0
40.0'
SANITARY MANHOLE
EXISTING C.M.P. TO BE REMOVED
20.0'
INLET
710
SANITARY LIFT STATION
4' SIDEWALK
48" R.C.P. INTERCEPTOR
48" R.C.P.
PUMP STATION
15.0'
RW-15
RW-16
RW-17
12.0'
TOP OF DRIVE EL. 713.5
RW-18
3 - 14" DISCHARGE PIPES
LOADING DOCK EL. 714.75
66" R.C.P.
715
720
725
49+00
47+00
GATEWELL C
705
2 - 48" R.C.P.
PZ27



2

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

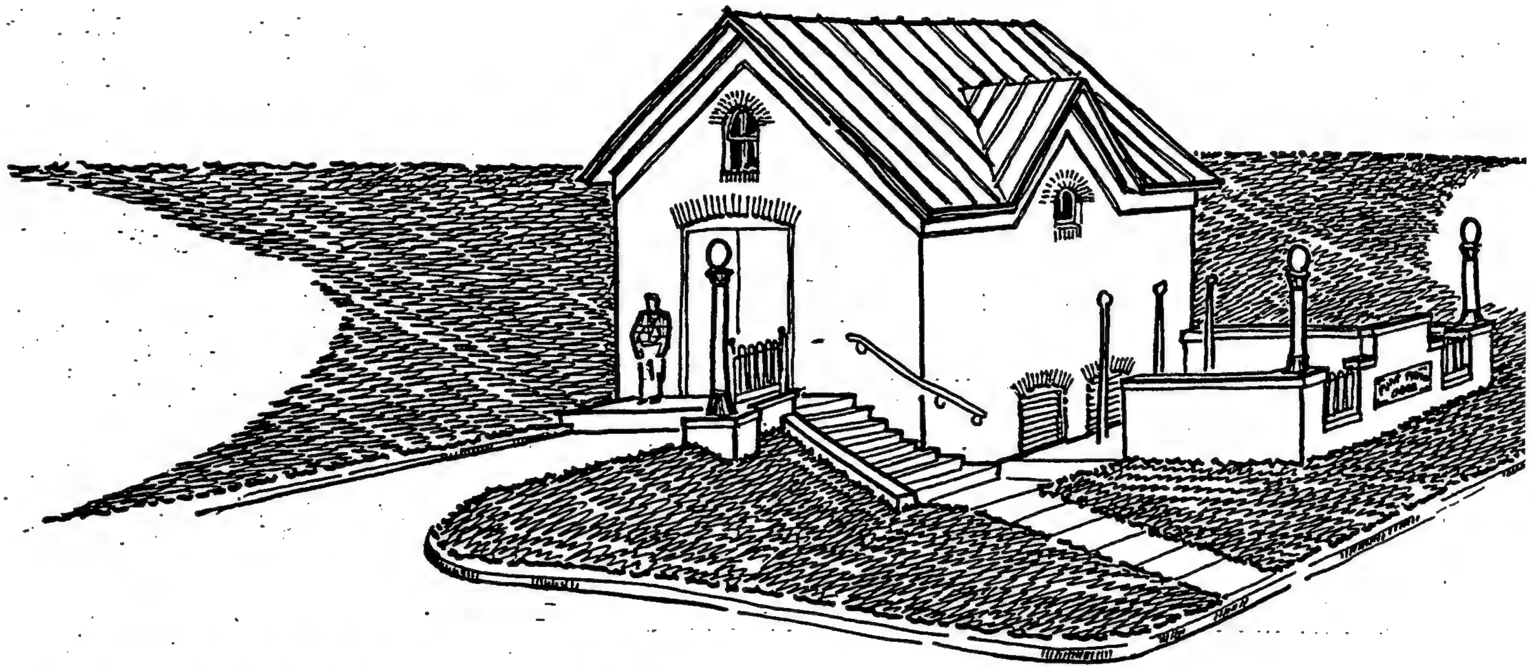
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA

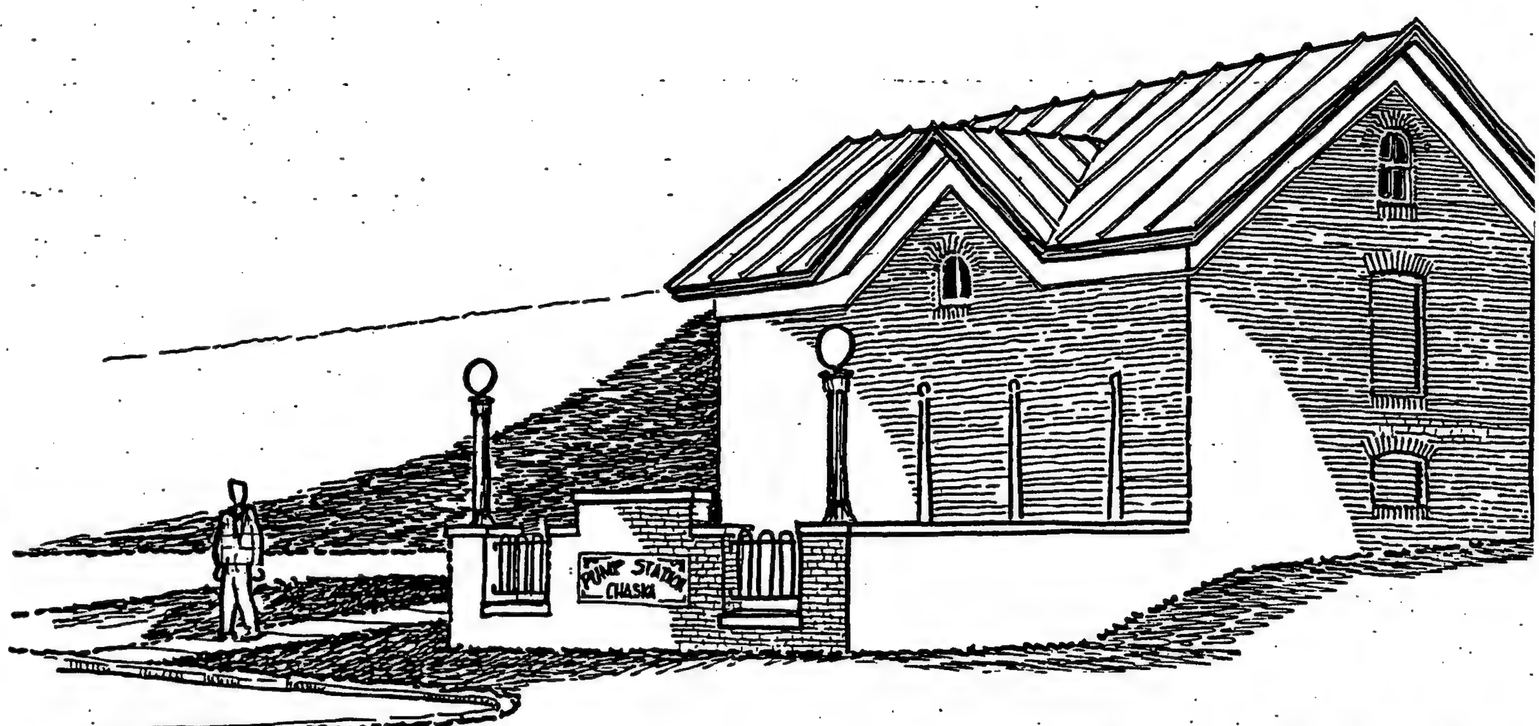
PUMP STATION
OUTLET C
SITE PLAN

ED-D	DESIGNED:	NRH
ED-D	CHECKED:	GRS
ED-D	DRAWN:	LKT
ED-GH	DESIGNED:	
ED-GH	CHECKED:	

DATE: MARCH 1991
CAD FILE NAME: NCGIR224.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/224
SHT 25 OF 31

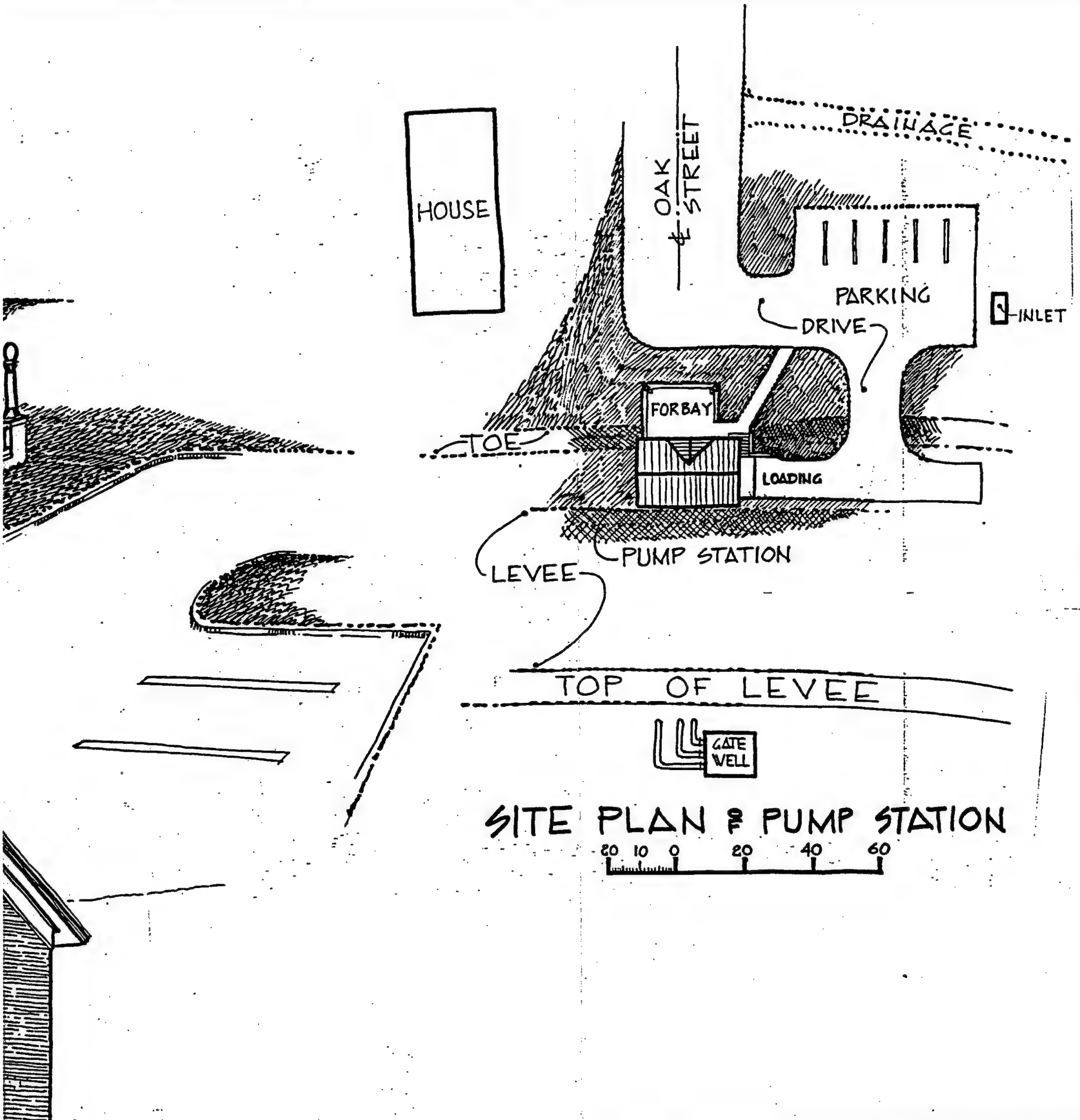


VIEW LOOKING S.W.



VIEW LOOKING

1



IG S.E.

SYMBOL	DESCRIPTION	DATE	APPROVAL

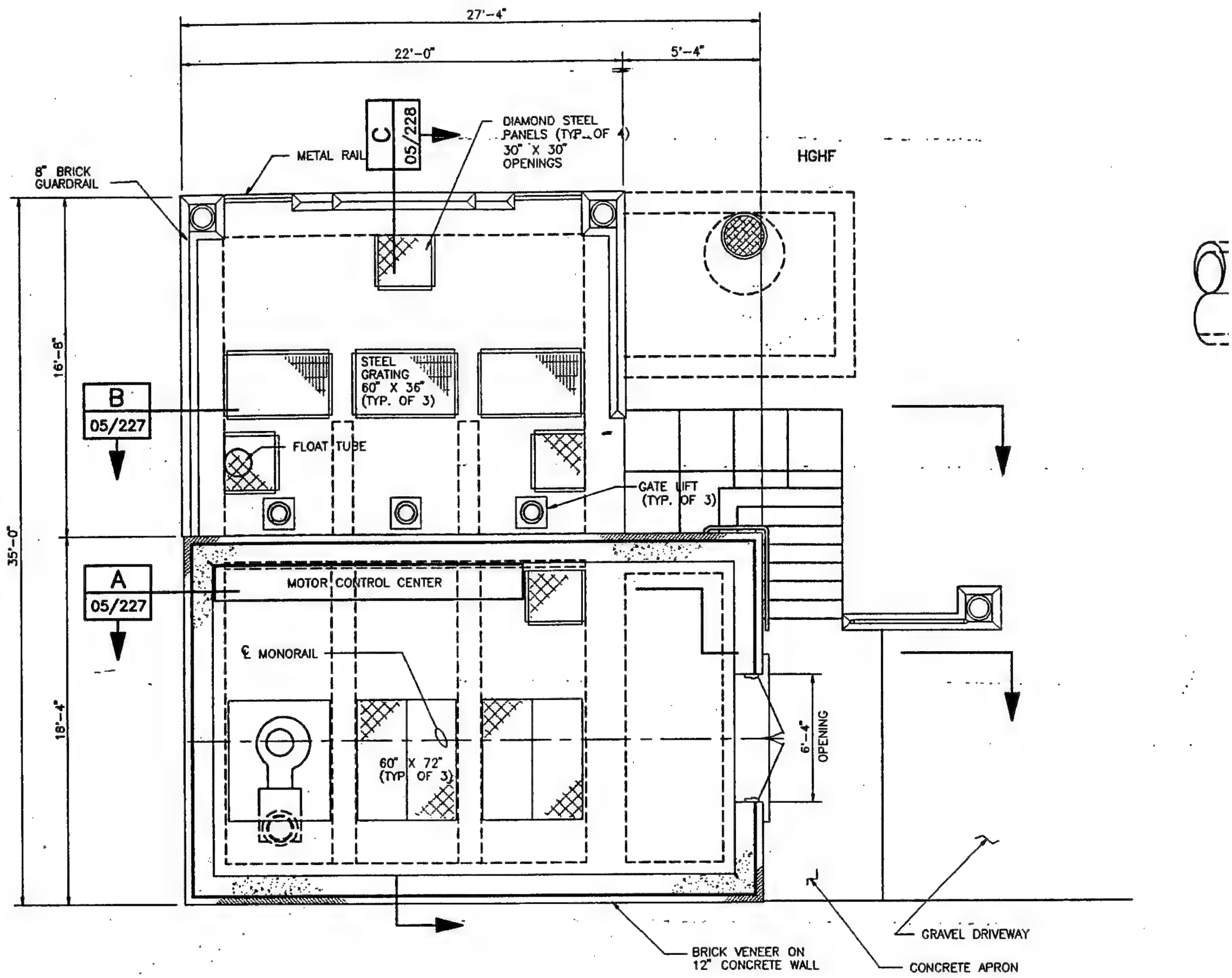
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:	DESIGN MEMORANDUM NO.2 CHASKA – STAGE 4 FLOOD CONTROL – MINNESOTA RIVER CHASKA PROJECT CHASKA, MINNESOTA PUMPING STATION SITE PLAN AND PERSPECTIVE SKETCHS
ED-D DESIGNED: PRK/CG	
ED-D CHECKED: PRK/CG	
ED-D DRAWN: CG/PPC	
ED-GH DESIGNED:	
ED-GH CHECKED:	CAD FILE NAME: MN05R225.DWG
DATE: 03-22-91	SPEC NO: SEE DWG. 05/200

DRAWING NUMBER: M34-CH-R-05/225

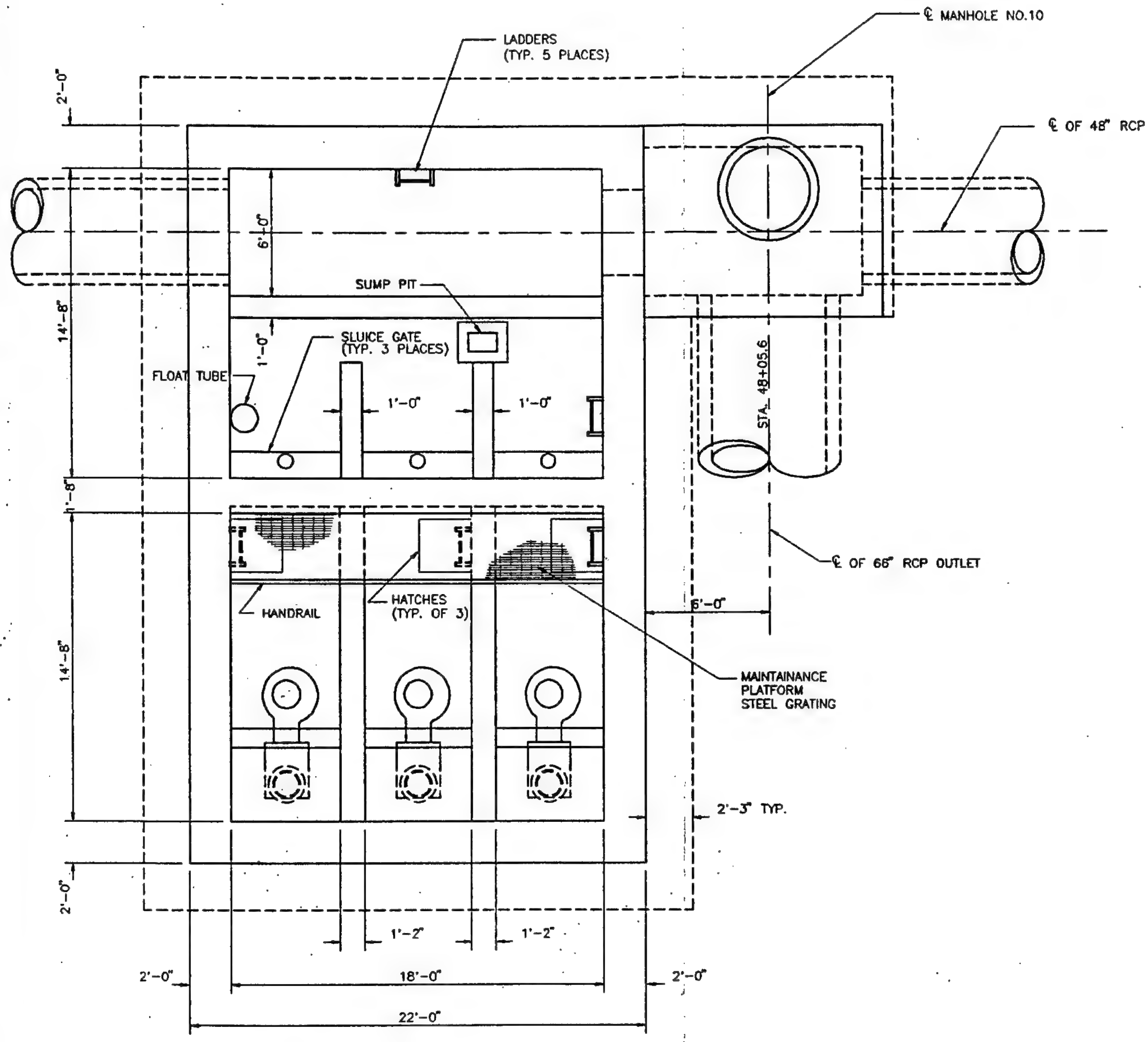
SHT 26 OF 31

2



PLAN

AT OPERATING LEVEL OF PUMP CHAMBER



PLAN
AT ELEV. 707.0

SCALE: 1/4" = 1'-0"

2

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

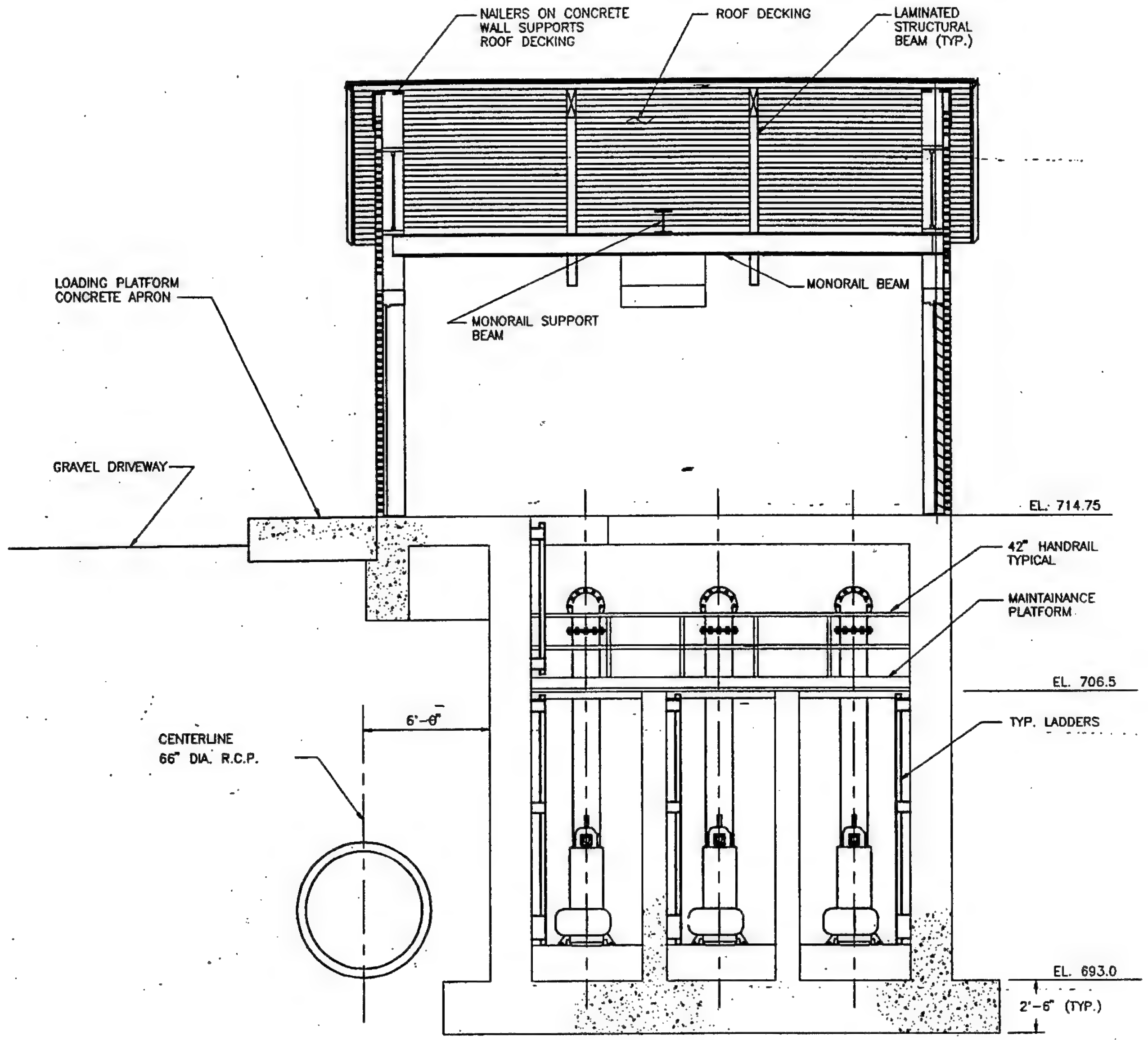
AE APPROVING OFFICIAL:

ED-D	DESIGNED:	PRK/CG
	CHECKED:	PRK/CG
	DRAWN:	PPC
ED-GH	DESIGNED:	
	CHECKED:	

DATE: 03-22-91

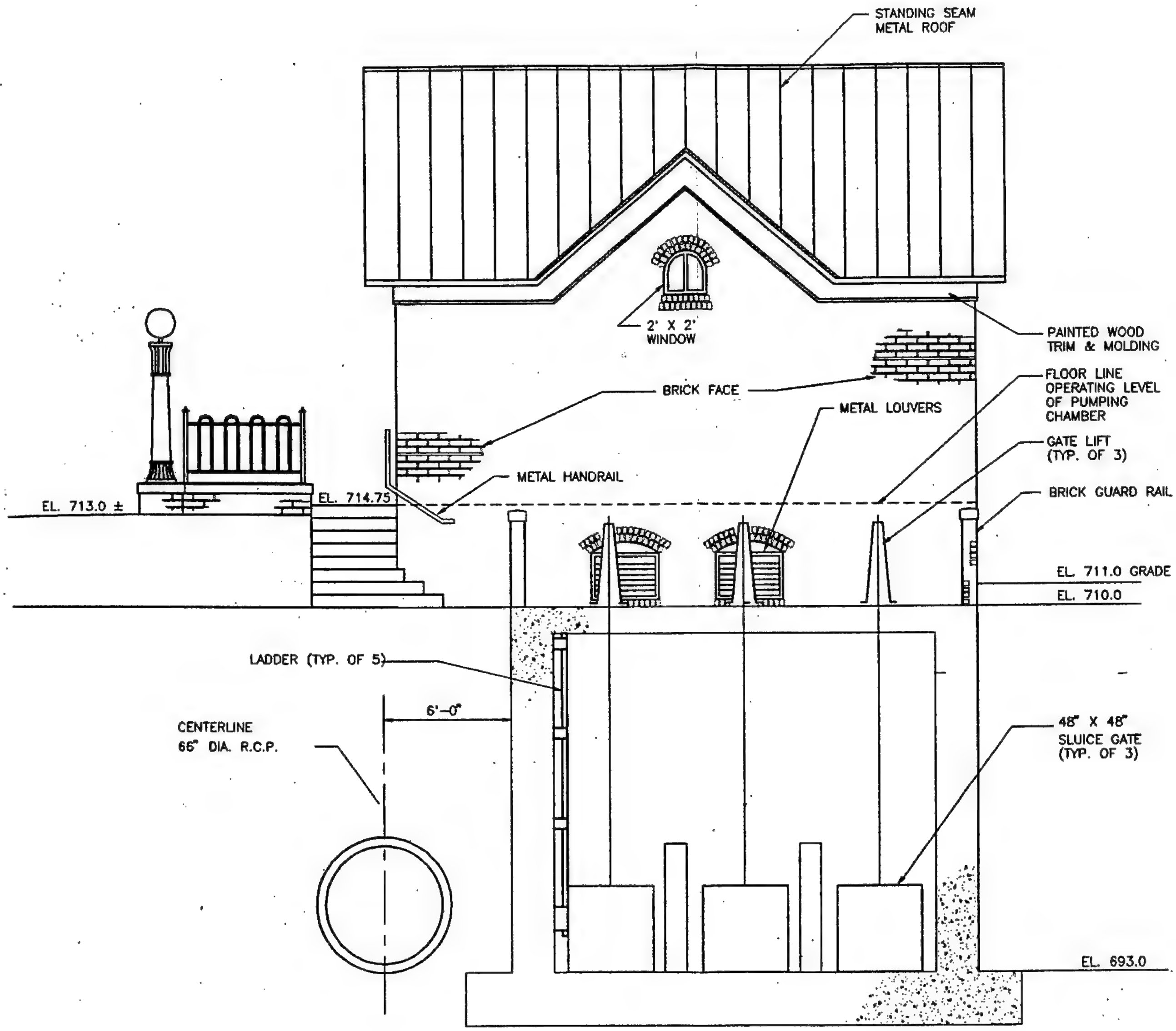
DESIGN MEMORANDUM NO.2
CHASKA – STAGE 4
FLOOD CONTROL – MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
PUMPING STATION
LAYOUT
PLANS

CAD FILE NAME: MN05R226.DWG
SPEC NO: SEE DWG. 05/200
DRAWING NUMBER: M34-CH-R-05/226
SHT 27 OF 31



SECTION A 05/226

MAIN OPERATING LEVEL AND PUMP CHAMBER



SECTION B
FORBAY AND OPERATING LEVEL OF FORBAY 05/226

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

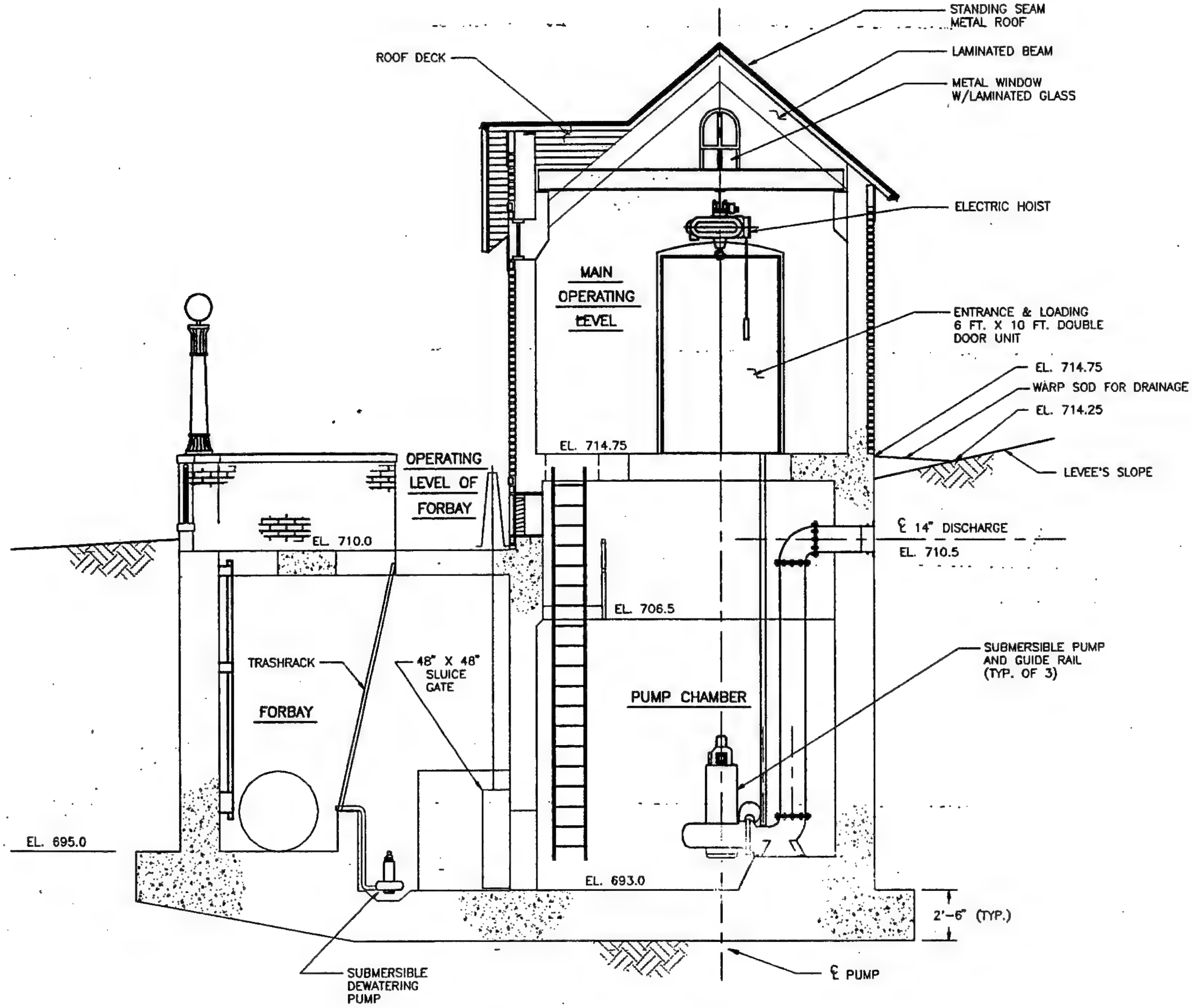
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO.2
CHASKA – STAGE 4
FLOOD CONTROL – MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
PUMPING STATION
LAYOUT
SECTIONS

ED-D	DESIGNED:	PRK/CG
	CHECKED:	PRK/CG
	DRAWN:	PPC
ED-GH	DESIGNED:	
	CHECKED:	

DATE: 03-22-91
CAD FILE NAME: MN05R227.DWG
SPEC NO: SEE DWG. 05/200
DRAWING NUMBER: M34-CH-R-05/227
SHT 28 OF 31

2



SECTION C
FORBAY AND PUMP CHAMBER 05/226

R DRAINAGE

SLOPE

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

ED-D	DESIGNED:	PRK/CG
ED-D	CHECKED:	PRK/CG
ED-D	DRAWN:	PPC
ED-GH	DESIGNED:	
ED-GH	CHECKED:	

DATE: 03-22-91

DESIGN MEMORANDUM NO.2
CHASKA – STAGE 4
FLOOD CONTROL – MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA

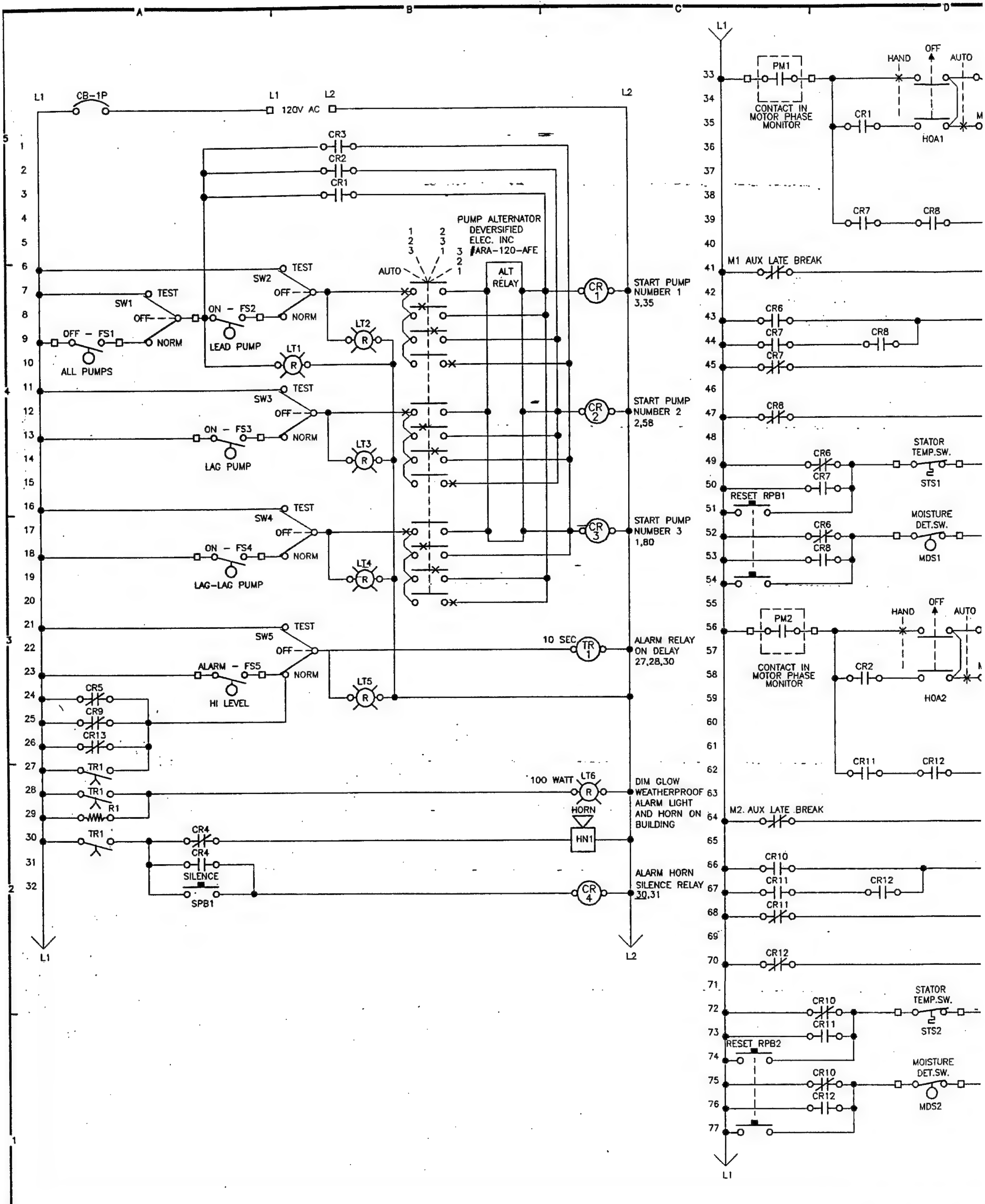
PUMPING STATION
LAYOUT
SECTION AND DETAILS

CAD FILE NAME: MN05R228.DWG
SPEC NO: SEE DWG. 05/200

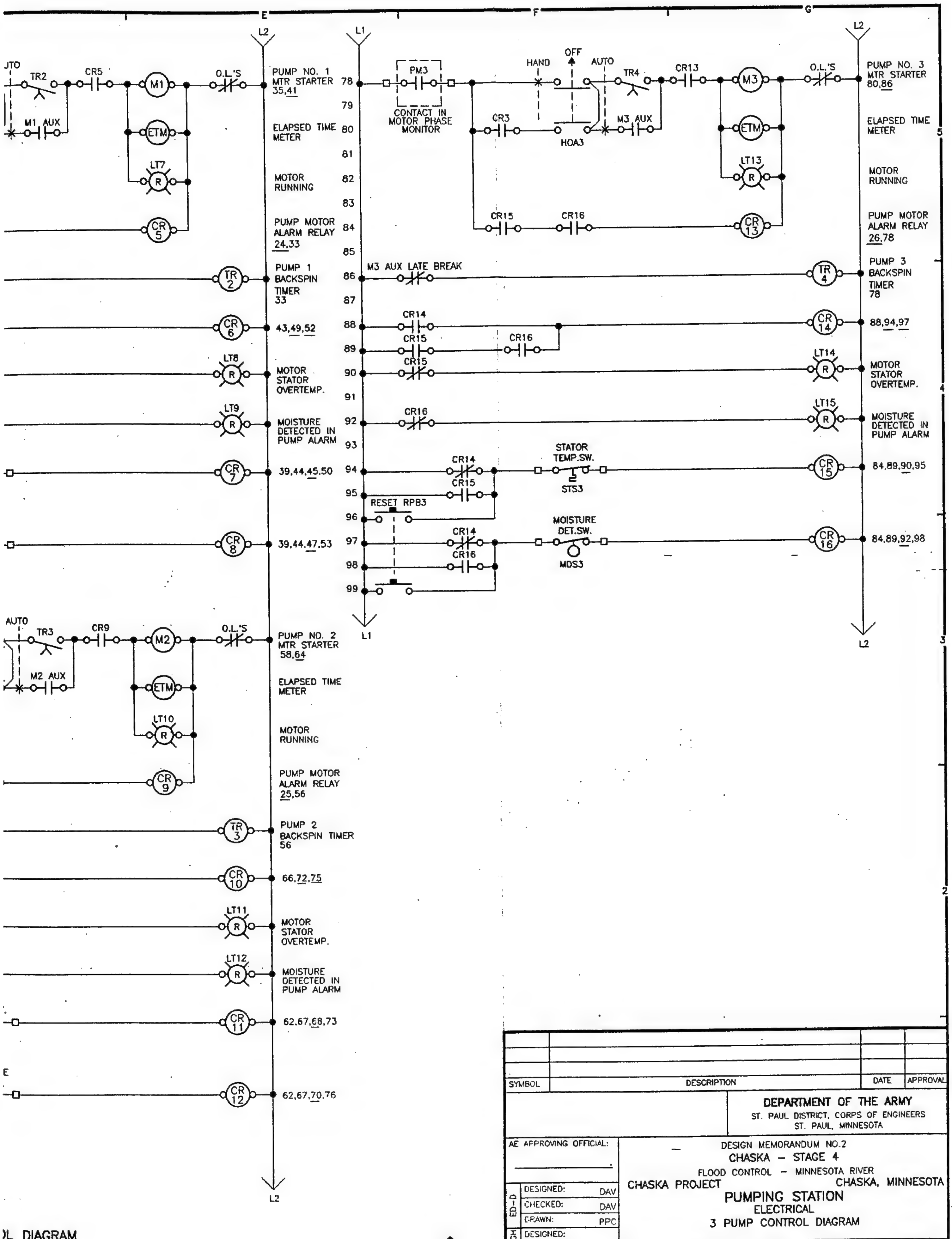
DRAWING NUMBER: M34–CH–R–05/228

SHT 29 OF 31

2



3 PUMP CONTROL DI



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

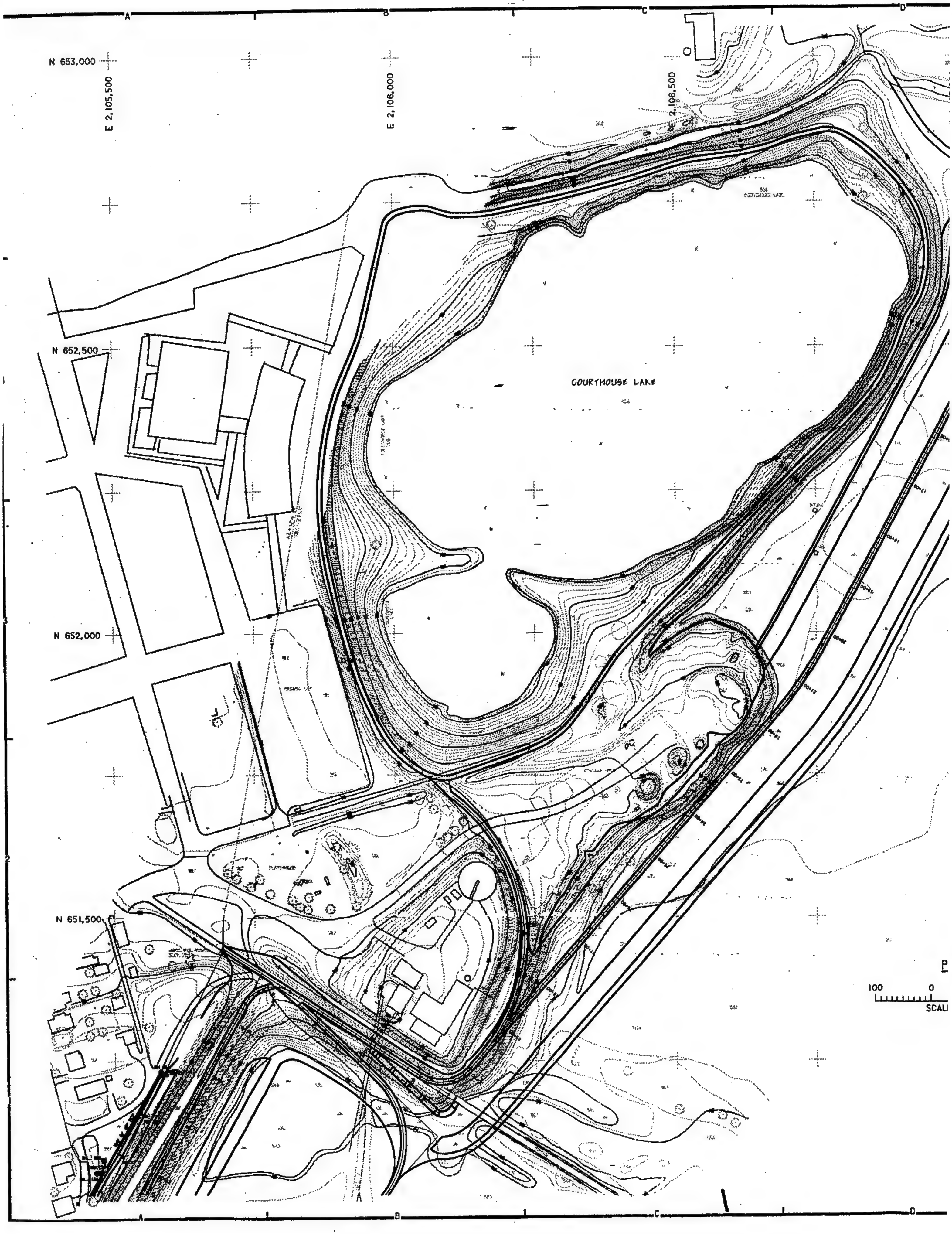
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO.2
CHASKA – STAGE 4
FLOOD CONTROL – MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
PUMPING STATION
ELECTRICAL
3 PUMP CONTROL DIAGRAM

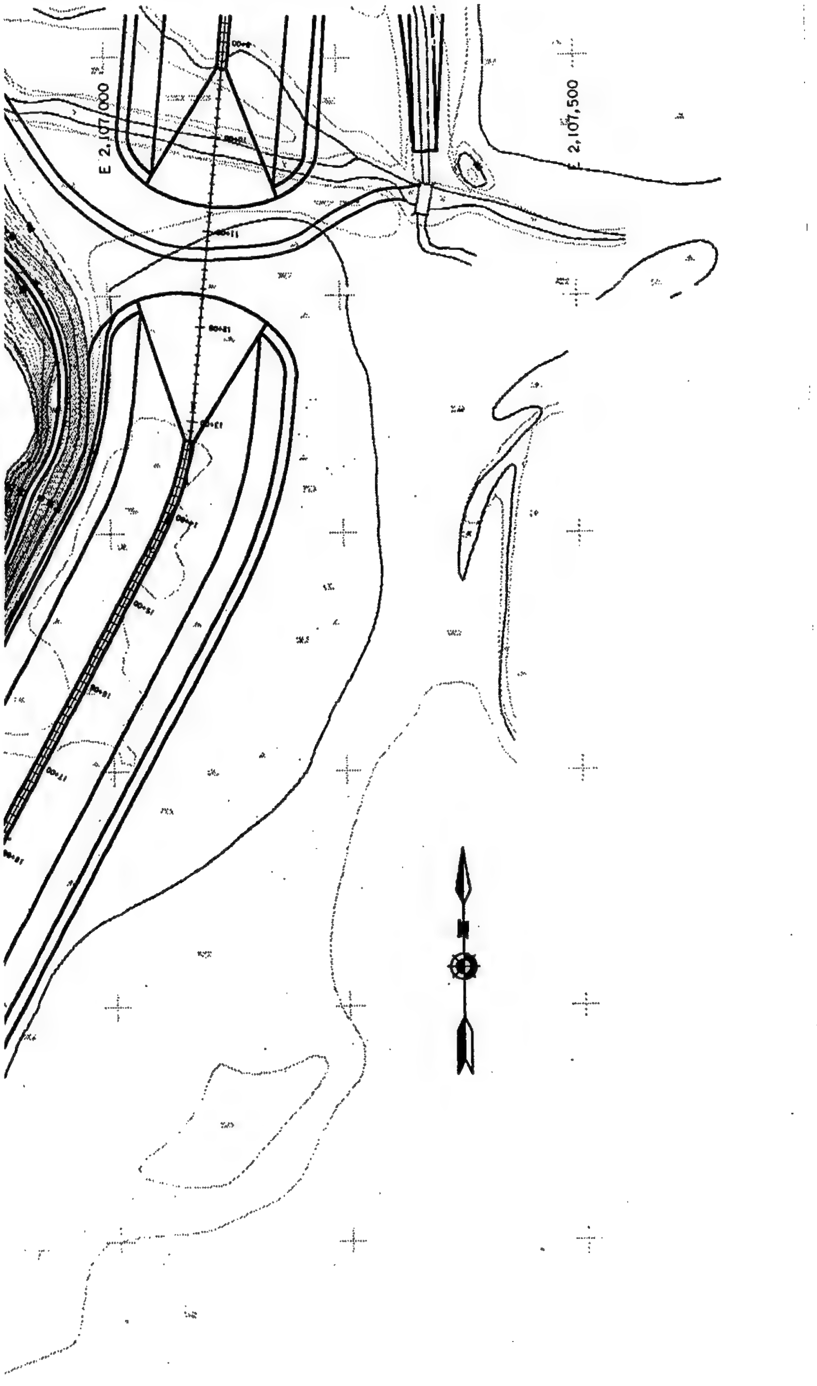
ED-D DESIGNED: DAV
CHECKED: DAV
DRAWN: PPC
ED-GH DESIGNED:
CHECKED:
DATE: 03-22-91

CAD FILE NAME: MN05R229.DWG
SPEC NO: SEE DWG. 05/200
DRAWING NUMBER: M34-CH-05/229
SHT 30 OF 31

2

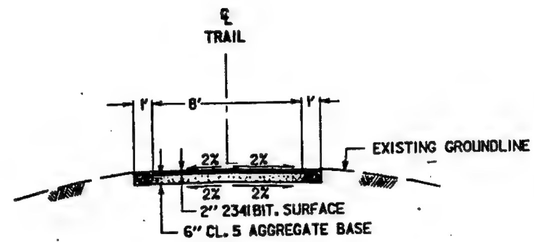


A
B
C
D
N 653,000
E 2,105,500
E 2,106,000
E 2,106,500
N 652,500
COURTHOUSE LAKE
N 652,000
N 651,500
100
0
SCAL
P



PLAN

0 100 200
SCALE IN FEET



TYPICAL SECTION

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

ED-D	DESIGNED:	R.J.M.
	CHECKED:	J.J.G.
	DRAWN:	R.J.M.
ED-GH	DESIGNED:	
	CHECKED:	
DATE:	MAR 1991	

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL – MINNESOTA RIVER
CHASKA PROJECT CHASKA, MINNESOTA
COURTHOUSE LAKE TRAIL
GENERAL PLAN & SECTION

CAD FILE NAME: MNIDPO20.DGN
SPEC NO:
DRAWING NUMBER: M34-CH-R-5/230
SHT 31 OF 31

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APPENDIX A

INTERIOR FLOOD CONTROL

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX A

INTERIOR FLOOD CONTROL

TABLE OF CONTENTS

ITEM	PAGE NO.	PARAGRAPH(S)
EXISTING CONDITIONS		
DESCRIPTION OF WATERSHEDS AND DRAINAGE PATTERNS FOR SECTION 1, 2, AND 3	A-1 - A-2	A-1 - A-5
PONDING AREAS	A-2	A-6
DAMAGE-ELEVATION RELATIONSHIPS	A-2	A-7
RIVER DISCHARGE AND STAGE DATA	A-3	A-8 - A-10
RAINFALL DATA	A-3 - A-4	A-11 - A-12
RUNOFF HYDROGRAPHS	A-4	A-13 - A-14
SEEPAGE	A-4	A-15
RECOMMENDED PLAN		
GENERAL	A-4 - A-5	A-16
DEPARTURES FROM GENERAL DESIGN MEMORANDUM, SUPPLEMENT NO. 1	A-5	A-17
GRAVITY OUTLETS	A-5	A-18 - A-19
RIPRAP REQUIREMENTS	A-5 - A-6	A-20
STORMSEWER FROM SECTION 1	A-6	A-21
DESIGNATED PONDING AREAS	A-6	A-22
INTERCEPTOR STORM SEWER	A-6	A-23
PUMPING STATION	A-6	A-24
PLAN OF OPERATION	A-6 - A-7	A-25 - A-26
PROJECT JUSTIFICATION		
PERFORMANCE OF PROPOSED STORMWATER SEWERAGE SYSTEM AND GRAVITY OUTLETS	A-7	A-27
SELECTION OF GATE CLOSURE ELEVATION	A-7	A-28
JUSTIFICATION OF PUMPING STATION	A-8 - A-9	A-29 - A-33
DESIGN CRITERIA		
DESIGN OF GRAVITY DESIGH FEATURES	A-9 - A-10	A-34 - A-36
RIPRAP DESIGN	A-10	A-37
DESIGN OF PUMPING STATION	A-10 - A-11	A-38 - A-45
ALTERNATE PLANS	A-11 - A-12	A-46 - A-48
REFERENCES	A-12 - A-14	A-49

TABLES

NUMBER	TITLE	PAGE NO.
A-1	ACCUMULATED 96-HOUR THEORETICAL RAINFALL AMOUNTS	A-15
A-2	HOURLY INCREMENTAL RAINFALL AMOUNTS	A-15
A-3	INCREMENTAL RAINFALL IN 4-2-1-3 DISTRIBUTION	A-16
A-4	HISTORICAL RAINFALL WITH 48-HOUR ACCUMULATION OF 3.00 INCHES OR MORE	A-17
A-5	HISTORICAL RAINFALLS WITH A DAILY TOTAL OF 0.4 INCHES OR MORE WHICH OCCURRED DURING OR JUST PRIOR TO A PERIOD TO A PERIOD OF BLOCKED GRAVITY DRAINAGE	A-18 - A-19
A-6	INTERIOR WATERSHED CHARACTERISTICS	A-20
A-7	UNIT HYDROGRAPHS	A-21
A-8	RUNOFF HYDROGRAPHS, 100-PERCENT EVENT	A-22
A-9	RUNOFF HYDROGRAPHS, 40-PERCENT EVENT	A-23
A-10	RUNOFF HYDROGRAPHS, 20-PERCENT EVENT	A-24
A-11	RUNOFF HYDROGRAPHS, 10-PERCENT EVENT	A-25
A-12	RUNOFF HYDROGRAPHS, 4-PERCENT EVENT	A-26
A-13	RUNOFF HYDROGRAPHS, 2-PERCENT EVENT	A-27
A-14	RUNOFF HYDROGRAPHS, 1-PERCENT EVENT	A-28
A-15	RUNOFF HYDROGRAPHS FOR HISTORICAL EVENTS (GRAVITY OUTLETS)	A-29
A-16	RUNOFF HYDROGRAPHS, STANDARD PROJECT STORM	A-30
A-17	RUNOFF HYDROGRAPHS FOR HISTORICAL EVENTS WITH SIGNIFICANT RAINFALL AMOUNTS WHICH OCCURRED DURING A PERIOD OF HIGH RIVER STAGES	A-31
A-18	INTERCEPTOR STORMSEWER DESIGN	A-32
A-19	DESIGN DISCHARGE RATES	A-33
A-20	REQUIRED SIZE OF GRATED INLETS AND CONNECTING FEEDER PIPES	A-34
A-21	ONE PERCENT AND STANDARD PROJECT FLOOD POND LEVELS	A-35
A-22	ESTIMATED SEEPAGE DURING A STANDARD PROJECT FLOOD	A-35
A-23	PERIODS WHEN MINNESOTA RIVER EQUALS OR EXCEEDED ELEVATION 706.0	A-36
A-24	CONVERSION OF POND LEVELS INTO DAMAGES	A-37
A-25	DETERMINATION OF AVERAGE ANNUAL PUMPING COSTS	A-38

PLATES

NUMBER	TITLE
A-1	LOCATION OF CONTRIBURING WATERSHEDS FOR INTERIOR FLOOD CONTROL
A-2	LOCATION OF SECTION 1 INTERIOR FLOOD CONTROL FACILITIES
A-3	LOCATION OF SUB-WATERSHEDS IN SECTIONS 2 AND 3
A-4	ELEVATION-AREA-STORAGE CURVES, STATION 1
A-5	ELEVATION-AREA-STORAGE CURVES, SECTION 2
A-6	ELEVATION-AREA-STORAGE CURVES, SECTION 3
A-7	DAMAGE-ELEVATION CURVES, SECTIONS 2 AND 3
A-8	ELEVATION-FREQUENCY CURVES, MINNESOTA RIVER AT CHASKA
A-9	ELEVATION-DISCHARGE CURVE, MINNESOTA RIVER AT CHASKA CREEK, PROPOSED CONDITIONS
A-10	STAGE-DURATION CURVES, MINNESOTA RIVER AT CHASKA CREEK
A-11	STANDARD PROJECT FLOOD STAGE-DISCHARGE HYDROGRAPHS, MINNESOTA RIVER AT CHASKA, MINNESOTA
A-12	POINT RAINFALL DEPTH-FREQUENCY CURVES, CHASKA, MINNESOTA
A-13	POINT RAINFALL DEPTH-DURATION CURVES, CHASKA, MINNESOTA
A-14	ELEVATION-DISCHARGE CURVE FOR EXISTING 24-INCH STORMSEWER FROM SECTION 1
A-15	ELEVATION-DISCHARGE CURVES, GRAVITY OUTLETS IN SECTIONS 2 AND 3, EXISTING CONDITIONS
A-16	ELEVATION-HEAD-DISCHARGE CURVES, FOR OUTLETS B AND C, PROPOSED CONDITIONS
A-17	POND ELEVATION-FREQUENCY CURVES, PROPOSED OAK STREET PUMPING STATION
A-18	DAMAGE - FREQUENCY CURVES, OAK STREET PUMPING STATION
A-19	STATION CAPACITY-AVERAGE ANNUAL COST CURVE, PROPOSED OAK STREET PUMPING STATION
A-20	AVERAGE ANNUAL COST-BENEFIT RELATIONSHIPS, PROPOSED OAK STREET PUMPING STATION
A-21	PROFILE OF PROPOSED OUTLET B UPSTREAM OF CHESTNUT STREET
A-22	PROFILE OF PROPOSED OUTLET C AT OAK STREET
A-23	PREFORMED SCOUR HOLE, OUTLETS B AND C
A-24	PROFILE OF PROPOSED INTERCEPTING STORMSEWER AT CHASKA
A-25	SYSTEM HEAD-CAPACITY CURVES, PROPOSED OAK STREET PUMPING STATION

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX A

INTERIOR FLOOD CONTROL

EXISTING CONDITIONS

DESCRIPTION OF WATERSHEDS AND DRAINAGE PATTERNS FOR SECTIONS 1, 2, AND 3

A-1. The city of Chaska is located along the north floodplain of the Minnesota River generally between East and Chaska Creeks. The interior flood control basin for the entire city of Chaska consists of about 1,130 acres along Chaska Creek, East Creek and the north side of the Minnesota River. The portion of the basin contributing runoff to the stage 4 reach of levee is shown on Plate A-1 as Sections 1, 2, and 3.

A-2. Section 1, shown on Plate A-2, consists of about 36 acres which contribute runoff to the Chaska Creek channel below the proposed point of diversion. Most of the runoff from the section flows overland generally to the southeast or northwest into the former creek channel (now a designated ponding area), thence to the southwest in said channel to the newly constructed levee where this runoff is carried to the existing Chaska Creek channel through a newly installed 60-inch RCP gated gravity outlet (A). (The flood barrier and gravity outlet were installed as part of the Stage 2 construction.) The runoff from a small portion of the Section 1 watershed located east of the flood barrier and north of First Street which can not reach the existing creek channel by overland flow is carried by a newly constructed stormsewer into Section 2. This stormsewer, also part of the Stage 2 construction, consists of about 1175 feet of permanent RC pipe varying in size from 12- to 24-inches in diameter. (As indicated in paragraph A-21, this stormsewer has been temporarily extended an additional 570 feet.) Section 1 is relatively flat with elevations ranging from about 735(*) in the northeast to about 714 in the southwest. Land use in the area is predominantly residential. During periods of high river stages, runoff will temporarily pond in the designated ponding area, pass through the newly constructed (First Street) stormsewer into Section 2, and/or pass through the 60-inch gravity outlet into Chaska Creek.

A-3. Section 2, shown on Plates A-1 and A-3, includes about 52 acres tributary to the existing gated 36-inch RCP outlet at Elm Street and the existing gated 24-inch RCP outlet just west of Highway 41, both of which pass beneath the existing dike into the Minnesota River. (The location of the outlets are shown on Plate A-3 and further described on Plate A-15.) Runoff from the 52 acres and from the First Street stormsewer outlet, located near the inside toe of the existing dike about 800 feet west of Hickory Street, flows feet west of Hickory Street, flows overland to the east or south to the outlets described above. In Section 2, ground level elevations vary from about 735 at the north end to about 710 at the south end. Land use in the

*All elevations indicated in this appendix refer to National Geodetic Vertical Datum of 1929.

area is largely residential with a small amount of commercial property along Chestnut Street. During blocked gravity conditions, an existing 9,000 gallon per minute (gpm) pumping station, located at the south end of Elm Street, is used to remove runoff from Section 2. (As indicated on Plate A-3, this area has been further subdivided into six subsections for use in the design of the proposed interceptor stormsewer.)

A-4. Section 3, shown on Plates A-1 and A-3, consists of about 58 acres tributary to the existing gated 18-inch RCP outlet at Walnut Street and the existing gated 36-inch RCP outlet at Maple Street, both of which also pass under Street, both of which also pass under the existing dike into the Minnesota River. The location of the outlets are shown on Plate A-3 and further described on Plate A-15. In other respects, section 2 is similar to section 2. During blocked gravity conditions, an existing 9,000 gpm pumping station, located at the south end of Maple Street, is used to remove runoff from section 3. (As indicated on Plate A-3, this area has been further subdivided into seven subsections for use in the design of the proposed interceptor stormsewer.)

A-5. The city of Chaska does not have an extensive storm sewer system. There are a few outlets located under the existing emergency Minnesota River levee, and a newly laid sewer installed in connection with the new Highway 41 bridge across the Minnesota River. Runoff from the remainder of the city area is by overland flow. According to a representative from the city, future storm-sewers are to be designed to carry the runoff from about a 20-percent rainfall event, if there are good overflow conditions in the area; and a 10-percent event if overland flow conditions are relatively poor. The use of supplemental retention basins at interior locations is encouraged and such basins are to be designed to contain the runoff from a 1-percent event.

PONDING AREAS

A-6. There are currently several ponding areas inside the proposed protected area. In section 1 there is the former Chaska Creek channel adjacent to outlet A, and in section 2 and 3 there are the low areas along the existing dike. Under proposed conditions, the only designated ponding area will be located in the former Chaska Creek channel just upstream from outlet A. About 1.7 acre feet of storage is to be provided between elevations 713.5 and 718.5, which will require about 1.55 acres of ponding easements. The sides of the ponding area are to be graded, topsoiled and seeded to permit proper maintenance of the area. Also ponding markers are to be added as required. In sections 2 and 3, fill required for geotechnical reasons will virtually eliminate any storage available below the zero damage elevations. Elevation-area-storage curves for sections 1, 2, and 3 are presented on Plates A-4, A-5 and A-6, respectively.

DAMAGE-ELEVATION RELATIONSHIPS

A-7. Elevation-damage curves developed for Sections 2 and 3 are presented on Plate A-7, and were obtained by updating the curves presented on plates B-9 and B-10 of the revised General Design Memorandum (August 1984) to October 1990 price levels. The zero damage level for sections 2 and 3 are 711.0, and 710.5, respectively. Additional information relative to the development of the damage-elevation relationships and the location and type of damage which would occur are presented in Appendix E of the 1984 Design Memorandum.

RIVER DISCHARGE AND STAGE DATA

A-8. Elevation-frequency curves for the Minnesota River at Chaska, obtained from Plate 4 A-4 of the Limited Reevaluation Report, dated August 1982, are presented on Plate A-8. An elevation-discharge curve for the Minnesota River at Chaska Creek (one of a family of curves developed from HEC-2 backwater profiles) is shown on Plate A-9. A stage-duration curve for the Minnesota River at Chaska Creek is presented on Plate A-10. A standard project flood (SPF) hydrograph for the Minnesota River at Chaska is presented on Plate A-11.

A-9. The United States Geological Survey (U.S.G.S.) has maintained a stream gaging station on the Minnesota River near either Carver or Jordan since 1934. The U.S.G.S. gage was originally located near Carver, Minnesota, (river mile 36.0) but in 1966 was moved to its present location near Jordan, Minnesota, (river mile 39.4) about 9.8 miles upstream from Chaska. The drainage area of the Minnesota River is about 16,200 square miles at the Jordan gage site and about 16,600 square miles at Chaska. Since this is a relatively small increase in drainage area, the discharge-frequency relations at the Jordan gage were also used for Chaska. At the selected gate closure elevation of 706.0, the discharge in the Minnesota River is about 16,000 cfs., which is equalled or exceeded about 4.3 percent of the time (or return period of once in 24 years.)

A-10. The SPF hydrograph for the Minnesota River at Chaska was obtained by increasing the flow rates obtained from the SPF hydrograph for Mankato by the ratio of their respective peak flow rates. The estimated peak SPF flow rate of 168,000 cfs at Chaska was obtained from paragraph 11, page A-3 of the revised GDM for Chaska, dated August 1984. The SPF hydrograph for the Minnesota River at Mankato was obtained from Plate A-20, "Flood Control, Minnesota River, Minnesota, Report On Probable Maximum Floods And Standard Project Floods, Minnesota River Basin, Minnesota," dated January 1971.

RAINFALL DATA

A-11. The 1/4, 1/2, 1-, 2-, 3-, 6-, 12-, 24-, 48-, and 96-hour point rainfall depths for the 100-, 40-, 20-, 10-, 4-, 2-, and 1-percent all-year theoretical rainfall events in the Chaska area were developed from National Weather Service (U.S. Weather Bureau) publications HYDRO-35, TP-40, and TP-49 and are presented on Plates A-12 and A-13 and in Table A-1. The incremental rainfall amounts at 10-minute intervals are presented in Table A-2. The incremental rainfall amounts based on a 4-2-1-3 distribution are presented in Table A-3. The point rainfall amounts for the standard project storm, developed in accordance with criteria presented in EM 1110-2-1411, is also shown in Tables A-3 through A-13 and on Plates A-12 and A-13.

A-12. Historical rainfall data were obtained from the U. S. Department of Commerce publication "Climatological Data." Daily rainfall records for Chaska are available from August 1911 through 1988. Since there is no recording gage located in the Chaska area, estimated hourly rainfall amounts have been obtained by use of the hourly amounts from nearby recording gages and proportioning these recorded hourly amounts equal to the recorded daily rainfall amounts at Chaska. The recording gages used are located at either the Minneapolis-St. Paul international airport (located about 22 miles east-northeast of Chaska), LeSueur, Minnesota (located about 28 miles to the south west), Northfield, Minnesota (located about 32 miles to the southeast), or at

Hutchinson, Minnesota (located about 40 miles to the west-northwest). The estimated hourly rainfall distribution for rainfall events at Chaska with a 48 hour total of 3 inches of more are presented in Table A-4. The estimated hourly amounts for all events of 0.4 inches or more, which occurred when the Minnesota River equalled or exceeded elevation 706.0, are presented in Table A-5.

RUNOFF HYDROGRAPHS

A-13. Runoff hydrographs for each of the interior watersheds were developed based on criteria presented in Soil Conservation Service (SCS) Technical Release 55 (TR55), dated June 1986, titled: "Urban Hydrology for Small Watersheds," and using the SCS unit hydrograph method in the HEC-1 computer program. Key parameters used in the computer program are presented in Table A-6. The 10-minute and 60-minute unit-hydrographs obtained for each of the watersheds are presented in Table A-7. Runoff hydrographs for the 100-, 40-, 20-, 10-, 4-, 2-, and 1-percent and standard project storms for each of the 13 sub-watersheds of sections 2 and 3 and for the inflow from section 1 are presented in Tables A-8 through A-14 and A-16, respectively. Runoff hydrographs for the most intense rainfall events which occurred July 27, 1949; July 21, 1951, June 21, 1983, and July 21, 1987 are presented in Table A-15. Runoff hydrographs for historical events which occurred during high Minnesota River stages are presented in Table A-17.

A-14. The size of each sub-watershed and estimated ground slopes (presented in Table A-6) used to obtain time of concentrations were obtained from U.S.G.S. quad sheets. Time of concentrations were obtained using Worksheet 3 of TR55. The Manning's n value used assumes a dense grass ground cover. The two-year, 24-hour rainfall amount for Chaska was obtained from Figure III-1b, page III-8 of National Weather Service publication "Hydro - 35." Lag time was assumed to be equal to 60 percent of the time of concentration as defined on page 15-6, SCS National Engineering Handbook, Section 4, "Hydrology." The ratios of imperviousness used are the same as used in earlier reports and are indicated in Table A-6. The SCS curve numbers were obtained based on a soil group B and a antecedent moisture condition II.

SEEPAGE

A-15. The estimated seepage rates per foot of head used in the design of the proposed pumping station are 187.5 gpm in Section 2 (62.5 gpm between stations 55+00 and 59+00 and 125 gpm between stations 59+00 and 91+75) and 635 gpm in Section 3 (between stations 33+50 and 55+00). Seepage in Section 1 is considered to be insignificant. Seepage rates are further discussed in the "Seepage and Uplift Analysis" section of Appendix C.

RECOMMENDED PLAN

GENERAL

A-16. The recommended interior flood control plan will consist of two gated gravity outlets, including preformed scour holes; about 3,740 feet of intercepting storm sewer, including 16 street inlet structures located along the sewer line at each street intersection; and a new 18,000 gpm pumping station. The four existing RCP gravity outlets, and two 9,000 gpm pumping stations are to be removed. The required size, type, length, invert

elevations and hydraulic gradients for the proposed gravity outlets and stormwater interceptor sewers are presented in Tables A-18 and A-19 and on Plates A-21, A-22 and A-24. The required size, and rim elevation of the proposed grated street inlets are presented in Table A-20. The required facilities are further defined in the following paragraphs.

DEPARTURES FROM GENERAL DESIGN MEMORANDUM, SUPPLEMENT NO. 1

A-17. Based on revised hydrology for Sections 2 and 3, the recommended size off of the gravity outlet in section 2 was decreased from a 90-inch RCP to a 72-inch RCP, and the recommended size of gravity outlet for section 3 was decreased from a 84-inch RCP to a 66-inch RCP. Revisions have also been made to the pipe sizes for the interceptor sewers in sections 2 and 3. A new stormsewer line from Section 1, constructed under Stage 2, has resulted in the required extension of the proposed interceptor sewer to the west. Also the design of the interceptor is now based on average antecedent moisture conditions, and to satisfactorily contain the runoff from a standard project storm. Based on the revised seepage quantities, the capacity of the proposed pumping station has been reduced from 23,000 gpm to 18,000 gpm.

GRAVITY OUTLETS

A-18. Outlet B, as shown on Plate A-21, is to be located beneath the levee in Section 2 just upstream of the Highway 41 bridge. The outlet is to consist of a 72-inch and twin 48-inch RCP with gatewell, sluice gate, and preformed scour hole. The 72-inch pipe will extend from the intercepting stormsewer downstream about 90 feet to the proposed concrete gatewell with sluice gate. The twin 48-inch pipe will extend from the gatewell downstream about 124 feet to the Minnesota River, where a preformed scour hole will be constructed. The 72-inch pipe will be layed with an inlet invert elevation of 693.5 and an outlet invert elevation of 693.0. The 48-inch pipes are to be layed with an invert elevation of 683.0. The preformed scour hole, as shown on Plate A-23, is to be constructed with a 12' x 16' base at elevation of 679.0 with 1 on 3 side slopes.

A-19. Outlet C, as shown on Plate A-22, is to be located beneath the levee in Section 3 near the end of Oak Street. The outlet is to consist of a 66-inch and twin 48-inch RCP with gatewell, sluice gate, and preformed scour hole. The 66-inch pipe will extend from the intercepting stornsewer downstream about 93 feet to the proposed concrete gatewell with sluice gate. The twin 48-inch pipe will extend from the gatewell downstream about 113 feet to the Minnesota River, where a preformed scour hole will be constructed. The 66-inch pipe will be layed with the same invert elevations as Outlet B. The 48-inch pipes are to be layed with an invert elevation of 683.0, and the preformed scour hole is to be constructed with the same elevations and dimensions used for Outlet B. Elevation-discharge curves for Outlets B and C are presented on Plates A-16.

RIPRAP REQUIRMENTS

A-20. A 12-inch layer of riprap is required over the proposed preformed scour holes and about 20 feet in each direction from the scour holes and to each side and above the two proposed gravity outlets. Based on a stone specific weight of 165 lbs./cu. ft. and a 12-inch layer, the required stone graduation is as follows:

Percent Lighter By Weight	Weight Limits Maximum	Minimum
100	86	35
50	26	17
15	13	5

STORMSEWER FROM SECTION 1

A-21. Most runoff from Section 1 will enter this sewer to the north and west of First Street at inlets 12 and 12d. Inlet 12 consits of a Neenah grate type R-2561 with a rim elevation of 717.3. Inlet 12d consists of a Neenah grate type R-3067v with a rim elevation of 716.0. Runoff entering these two structures is carried by stormsewer to a manhole 12c where it discharges into the same sewer. The sewer connecting inlet 12 with manhole 12c consists of 243 feet of 15-inch RCP. The sewer connecting inlet 12d with manhole 12c consists of 44 feet of 12-inch RCP and 200 feet of 18-inch RCP. From manhole 12c to the proposed Inlet 1 will consist of about 622 feet of 24-inch RCP with an outlet invert elevation of about 701.37. An elevation-discharge curve for this sewerage system is presented on Plate A-14.

DESIGNATED PONDING AREAS

A-22. There will be no designated ponding areas in sections 2 and 3.

INTERCEPTOR STORM SEWER

A-23. An intercepting storm sewer, about 3,740 feet long, will be required along the inside toe of the Minnesota River levee and berm from the permanent outlet of the stage 2 stormsewer located southwest of Spruce Street in Section 2 to the east of Maple Street near the downstream end of Section 3 to intercept local runoff and seepage. The required pipe sizes, lengths, and invert elevations for the proposed intercepting stormsewer are presented in Table A-18 and shown on Plate A-24.

PUMPING STATION

A-24. An 18,000 gpm pumping station, equipped with three 6,000 gpm pumps, is to be located near the end of Oak Street adjacent to Outlet C. The pumping station will discharge over the top of the levee into the gatewell of Outlet C. System head-capacity curves for the recommended pump are presented on Plate A-25. Criteria used in the design of the pumping station is presented in paragraphs A-38 through A-45.

PLAN OF OPERATION

A-25. During low river-gravity flow conditions, the sluice gates in gatewells B and C will be open. Runoff from section 1 will flow into the portion of Chaska Creek below the point of diversion, down the creek bed and finally discharge through Outlet A into the Chaska Creek diversion channel, and/or through the interior stormsewer into Section 2. Runoff from Sections 2 and 3 will discharge by overland flow to the proposed levee, intercepted by the proposed inlet structures, and thence carried to Outlets, B and C, respectively, through the proposed intercepting stormsewers and thence into the Minnesota River.

A-26. During flood periods when the Minnesota River at the Highway 41 bridge equals or exceeds elevation 706.0, the sluice gates in gatewells B and C will be closed. The gates at the entrance to the pumping station will be opened and the pumps activated. When the river exceeds elevation 713.5, runoff from section 1 will pond adjacent to outlet A, and flow through the interior stormsewer into the Section 2 interceptor. (It will not be necessary to close the sluice gate in gatewell A unless the flap gate fails.) The proposed pumping station will be equipped for both automatic and manual control operations. The normal operating range of the pumps in the proposed pumping station will be between elevations 698.0 and 702.5. The pumps on levels are 701.5, 702.0, and 702.5 and all pumps will turn off at elevation 698.0.

PROJECT JUSTIFICATION

PERFORMANCE OF PROPOSED STORMWATER SEWERAGE SYSTEM AND GRAVITY OUTLETS

A-27. Since the minimum ground level landward of the proposed levee will be raised to only about one to two feet below the existing standard project storm (SPS) level, and there is no significant storage volume within this reach; the proposed stormwater sewerage system has been designed to contain the runoff from a SPS. In comparing the estimated peak runoff from a SPS, indicated in Table A-16, with the estimated peak runoff from the most intense historical rainfall events, presented in Table A-15; it is evident that the design SPS event is by far more severe than any historical event which has occuredd to date. An intercepting sewer plan based on a one-percent rainfall event would have resulted in SPS levels far higher than that which would have occurred under existing conditions. In addition to a hydraulics gradiant for the one-percent and SPS event, Table A-18 also includes a hydraulic gradiant for the runoff from a 10- and 20-percent event, because the City of Chaska plans to install a stormwater sewerage system designed to contain the runoff from these events. The estimated maaximum interior pond level and resulting flood damage in sections 2 and 3 resulting from a 1-percent and SPS with and without the project are presented in Table A-21. The maximum pond levels are taken from Table A-18. Damages were obtained from Plate A-7. Elevation-discharge curves for Outlets B and C based on existing and proposed conditions are presented on Plate A-15 and Plate A-16, respectively.

A twin 48-inch pipe is recommended downstream of each gatewell to permit the satisfactory outflow during a SPS event, a crown elevation below the estimated ice line and an outlet invert elevation above the bottom of the river channel. The low water elevation for the Minnesota River at Chaska is about 688.0, thus the maximum allowable pipe crown elevation to avoid the formation of ice within the pipe is assumed to be about 687.0. A preformed scour hole is required at the downstream end of these pipes to prevent damage from erosion and scour at the pipe outlets and to possibly prevent the formation of sedimentation deposits within the pipes.

SELECTION OF GATE CLOSURE ELEVATION

A-28. In Sections 2 and 3, the selected gate closure level is 706.0 to prevent the backup of runoff into the proposed relief wells. At this level, the flow in the Minnesota River is about 16,000 cfs, which is equalled or exceeded about 4.6 percent of the time.

JUSTIFICATION OF PUMPING STATION

A-29. The recommended 18,000 gpm pumping station is based on the estimated peak seepage rate which would occur during a standard project flood (SPF) on the Minnesota River, the capacity required based on a period of record - economic analysis, and the existing pumping capacity in Chaska. The estimated peak seepage rate which would occur during a SPF on the Minnesota River, as indicated in Table A-22, would be about 19,200 gpm based on a constant interior pond level of 706.0; however the estimated peak seepage rate expected during a SPF is about 18,000 gpm with an interior pond level of about 707.4. This level is only about 0.4 feet above the maximum allowable interior pond level required for the satisfactory operation of the proposed relief well system and can be expected to occur only during an extremely rare and short occassion. Based on a period of record - economic analysis, the most economical size of pumping station is about 17,800 gpm. There are currently two 9,000 gpm pumping stations located along the levee at Elm and Maple Streets. However with the required increase in pumping head, these existing stations will not be able to satisfactorily remove the interior runoff at this rate.

A-30. An economic-period of record analysis was used because of the potential for the occurrence of a significant amount of seepage with high river stages. The design of separate pumping stations for Sections 2 and 3 was found in earlier studies to be more costly than a single combined station and, therefore, was not considered during the current study. The location of the proposed pumping station was first considered at the end of Elm Street, however, its location has been moved downstream adjacent to Outlet C, to reduce project costs and because a good share of the pumped runoff will be from seepage through the levee and occur downstream of Highway 41.

A-31. Maximum pond levels which would have occurred during past periods of blocked gravity drainage with and without pumping are presented in Table A-23. Based on hourly rainfall records since 1949, there have been only two events when the Minnesota River at Chaska was above the selected gate closure level of 706.0 and there would have been an interior runoff rate greater than 18,000 gpm. During May 7-8, 1965 with the Minnesota River at about elevation 706.1 and the installation of an 18,000 gpm pumping station, the 2.1 inch recorded rainfall would have resulted in a peak runoff rate of about 26,303 gpm and resulted in the temporary storage of about 2.1 acre feet of runoff. During July 10-11, 1984 with the Minnesota River at about elevation 706.3 and the proposed pumping station in place, the 2.64 inch recorded rainfall would have resulted in a peak runoff of about 23,580 gpm and resulted in the temporary storage of about 2.1 acre feet of runoff. As indicated on Plates A-5 and A-6, the available storage below the zero damage level of 710.5 is about 1.2 acre feet in Section 2 and about 3.3 acre feet in Section 3, or about 4.5 acre feet in the combined areas. Also since the river level during these events was only about 0.3 feet or less above the selected gate closure level, the dates could have been temporarily opened to remove the excess runoff. (According to a representative from the City of Chaska, the two existing pumping stations were installed about 1951 and the city does not maintain detailed records on pumping operations.)

A-32. Based on the 53 years of record presented in Table A-23, there would have been 51 periods of blocked gravity drainage, and 28 years during which a flood period would have occurred. During this same period there would have

been about 819 days of blocked gravity drainage and a total of about 77.98 inches of precipitation. Assuming an average seepage rate of 812.5 gpm per foot of head, a constand interior pond level of 706.0, instantaneous seepage, and the Minnesota River rises to the peak and recedes linearly, the estimated seepage which would have occurred during the 53 year period is about 8,430 acre feet. Assuming 82 percent runoff, the estimated precipitation runoff during the period is about 586 acre feet. Based on a flood period occurring during 28 of the 53 years of record, the average flood frequency is about once every 2 years. The average duration of flooding is about 819 days during 51 events, or about 16 days. The total volume pumped would have been 9.016 acre feet. Distributed evenly during the 28 years of blocked gravity drainage, the 51 flood events, or the 53 years of record; this volume becomes about 322, 177, and 170 acre feet, respectively. Assuming only one of the 6,000-gpm pumps is operating, these volumes become about 292, 160, and 154 hours of pumping, respectively.

A-33. As indicated in Table A-18, the recommended highest pump-on level is about 702.50 feet. If this level is raised and the design 18,000 gpm discharge would occur, the hydraulic gradient in the intercepting stormsewer would exceed elevation 705.53. To permit the satisfactory operation of the proposed relief well system, it is recommended that the hydraulic gradient referably not exceed elevation 706.0 and definitely not exceed elevation 707.0.

DESIGN CRITERIA

DESIGN OF GRAVITY DESIGN FEATURES

A-34. The design of the interceptor sewers and gravity outlets is based on criteria presented in TM 5-820-4 and on the peak inflow from an SPS event. The design of the proposed intercepting sewers are based on the allowable head between the outlet invert elevation at Outlets B and C and the estimated SPS interior pond levels under existing conditions; 710.9 for the area upstream of Highway 41 (Section 2), and 712.5 for the area downstream of Highway 41 (Section 3). All gravity outlets, and permanent interceptor sewers are to be constructed of reinforced concrete pipe. (The temporary sewer segment constructed as part of stage 2 is to be PVC pipe.) The Manning's roughness coefficient for concrete and PVC pipe is assumed to be 0.014 and the entrance loss coefficient is assumed to be 0.5 for the gravity outlets and 0.2 for the interceptor sewers. The intercepting stormsewers are designed with matching crowns and on a constant slope of 0.002 feet/foot. (Elevation-head-discharge curves for outlets B and C for existing and proposed conditions are presented on Plates A-15 and A-16, respectively.) The hydraulic design of inlet structures, presented in Table A-20, is based on the criteria presented in TM 5-820-4, assuming 50 percent blockage, a rim elevation near the existing ground elevation, and a maximum allowable head equal to the difference between the selected rim elevation and the estimated SPS pond level under existing conditions.

A-35. The outlet invert elevations are set at 683.0 to eliminate the possibility of ice formation inside the pipe during the winter and/or spring months and subsequent loss of discharge capacity. As indicated on Plate A-10, the estimated mean average Minnesota River stage (i.e. a flow equalled or exceeded 50 percent of the time) is 691.7.

A-36. In Table A-18, two hydraulic gradients are provided to represent the

estimated runoff during blocked conditions. The discharge rates representing seepage only were obtained as indicated in Table A-19, assumming the Minnesota River at elevation 729.58 and the accumulation of seepage from the extremeties of the line of protection to the proposed pumping station located at Oak Street. The discharge rates representing the gravity (interior rainfall runoff) condition were obtained assumming an accumulative peak inflow rate of 40.1 cfs (18,000 gpm) at the pumping station with incremental inflow rates at each of the 13 proposed inlets equal to the ratio of the accumulative peak unit hydrograph rate for the given inlet to the total of the combined peak unit hydrograph rate from all inlets, times 40.1.

RIPRAP DESIGN

A-37. The design of the riprap cover required over and adjacent to the preformed scour holes and adjacent to the gravity outlets is based on criteria presented in HDC, sheet 7121 and ETL 1110-2-120, assuming a tailwater depth of 5 feet, a 48-inch outlet pipe, and a design discharge rate of 120 cfs at Outlet B and 127 cfs at Outlet C. The required minimum allowable 50-percent stone diameter is 0.164 feet, or about 2.0 inches. The minimum allowable 50-percent stone weight is 0.387 pounds.

DESIGN OF PUMPING STATION

A-38. The required capacity of the proposed pumping station was determined based on the larger required capacity obtained using an economic-period of record analysis, the estimated peak seepage rate during a SPF, and the existing pumping capacity available.

A-39. The estimated peak seepage rate during a SPF, as indicated in Table A-22, is estimated to be about 19,171 gpm, assuming seepage will occur at the rate of 812.5 gpm per foot of head and the interior pond level remains at elevation 706.0.

A-40. An economic-period of record analysis was performed based on the 53 years of record from 1 October 1934 through 30 September 1987; a selected gate closure level of 706.0; a combined seepage rate in Sections 2 and 3 of 812.5 gpm per foot of head; and selected station capacities of 5,000, 10,000, 15,000, and 20,000 gpm. Since there is only negligible ponding available at the lower levels, pumps are assumed to start and stop simultaneously at the selected gate closure level. The station design is based on criteria presented in EM 1110-2-3102 and EM 1110-2-3105.

A-41. The need for a pumping station during the 53 year period of record based on the selected pumping rates is summarized in Table A-23. The periods of blocked gravity drainage indicated in the table include all periods from 1934 through 1987 during which the Minnesota River stage at the Highway 41 Highway 41 bridge equalled or exceeded the proposed gate closure elevation of 706.0. The maximum river stages indicated are the maximum stages recorded during each period of blocked gravity drainage. The precipitation indicated in Table A-23 is the sum of all rainfall and/or snowmelt which occurred during the selected period based on the recorded daily amounts at Chaska. The maximum pond elevations reached during each period of blocked gravity drainage, with and without pumping, were estimated by routing all inflow (seepage and runoff) through the ponding area, and starting and stopping pumping operations at the selected gate closure level. To determine the most

critical condition, routings were performed first on a daily basis, then analyzed on an hourly basis using the runoff hydrographs presented in Table A-17. The gates on the gravity outlets are assumed to remain closed throughout the flood period.

A-42. Pond elevation-frequency curves developed for each selected pumping rate are presented on Plate A-17. A curve was developed for each pumping rate by rearranging the pond levels in descending order, ranking the pond levels from high to low, and assigning a plotting position for each pond level based on the Weibull statistical method presented in Bulletin No.17B.

A-43. Damage-frequency curves were then developed for each pumping rate and are shown on Plate A-18. These curves were obtained by converting the elevations indicated on Plate A-17 into damages based on the elevation-damage curves provided on Plate A-7, and then plotting a damage-frequency curve for each condition. The elevation-damage-frequency relations for each event are presented in Table A-24. Average annual damages were then determined by planimetering the area under each curve, and multiplying the resulting area in square inches times the average annual damages per square inch. Average annual benefits is equal to the difference between the average annual damages without pumping less the average annual damages for the given pumping rate.

A-44. The estimated first cost for constructing a new pumping station, is based on information received from the Cost Engineering Branch. The method and assumptions used to obtain estimated average annual pumping costs are presented in Table A-25. A pumping station cost-capacity curve is presented on Plate A-19.

A-45. The required size of pumping station was then obtained based on the capacity required to obtain maximum net benefits. This rate was obtained by plotting average annual pumping costs against average annual benefits, drawing the curve of best fit, and then drawing a straight line on a $1 benefit to $1 cost slope tangent to the curve. The point of intersection is the point of maximum net benefits. The average annual cost - average annual benefit curve for this study is presented on Plate A-20.

ALTERNATE PLANS

A-46. Four alternate intercepting sewer designs were considered. All plans assume the same pipe lengths, inlet locations, and design criteria, however, the proposed pipe elevations, and sizes vary with each plan. Plan A assumes Outlet B will be located at the end of Elm Street, Outlet C will be located near the end of Ash Street, and the inlet invert elevations to each outlet will be at 698.0. Plan B assumes Outlet B will be located at the end of Pine Street, Outlet C will remain near the end of Ash Street, and the inlet invert elevations to each outlet will remain at 698.0. Plan C assumes Outlet B at Pine Street, Outlet C moved upstream to the river end of Oak Street, and the outlet inlet invert elevations lowered to 693.5. Plan D is the recommended plan. Plans A and B were eliminated because of the larger pipe sizes required with the selected high outlet pipe invert elevations. Also with Plan A, Outlet B would discharge into Chaska Creek, where the existing channel is much narrower, the channel bottom is much higher and the tailwater conditions are more variable and may rise concurrently with outflow from the interior area. (Stages on the Minnesota River are much lower and will be relatively stable

during periods of interior runoff.) Plan C was eliminated, because the oulet runoff.) Plan C was eliminated, because the outlet pipe at Pine Street would be required to pass beneath an existing parking lot located riverward of the levee and subsequently require a relatively long segment of twin 48-inch outlet pipe.

A-47. Several alternate plans were considered for providing erosion and scour protection at the river end of Outlets B and C. One alternate was to extend the 72- and 66-inch pipes from the gatewell to the river with an invert elevation of 693.0, construct a concrete headwall at the downstream end, and lay a bed of riprap along the river bank to the bottom of the river. This plan was eliminated, because there is no assurrances that even a heavy bed of riprap could withstand the forces of the pipe outflow. (The estimated discharge velocity at the bottom of the river bank would be about 30 feet per second.)

A-48. Another alternate outlet plan was to extend both Outlets B and C to the Minnesota River and construct a St. Anthony Falls drop structure at the downstream end to dissipate the outflow energy. The required drop structure would require a drop of about 15 feet, a length of about 56 feet, a width of about 10 to 15 feet, with several baffle blocks and an end sill. This alternative was also eliminated, because of excessive cost, the required projection into the river, and/or its cutting into the levee cross-section.

REFERENCES

A-49. The following references were used in the development of the interior flood control plan:

a. EM 1110-2-1411, "Standard Project Flood Determination," (Civil Works Engineer Bulletin No. 52-8, March 1952).

b. EM 1110-2-1413, "Hydrologic Analysis of Interior Areas," January 1987.

c. EM 1110-2-1601, "Hydraulic Design of Flood Control Channels."

d. EM 1110-2-1602, "Hydraulic Design of Reservoir Outlet Works."

e. EM 1110-2-3101, "Pumping Stations-Local Cooperation and General Considerations."

f. EM 1110-2-3102, "General Principles of Pumping Station Design and Layout."

g. EM 1110-2-3105, "General Principles of Pumping Station Design and Layout."

h. ETL 1110-2-120, "Engineering And Design, Additional Guidance For Riprap Channel Protection."

i. TM 5-820-4, "Drainage for Areas Other Than Airfields."

j. Hydraulic Design Criteria, Sheet 712-1, "Stone Stability, Velocity Vs. Stone Diameter," Revised 9-70.

k. "Water Resources Data for Minnesota," U.S. Department of the Interior, Geological Survey.

l. National Weather Service HYDRO-35, "Five- to 60-Minute Precipitation Frequency For The Eastern And Central United States," June 1977.

m. National Weather Service Technical Report No. 40, "Rainfall Frequency Frequency Atlas of the United States," May 1961.

n. National Weather Service Technical Report No. 49, "Two- to Ten-day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States," 1964.

o. Soil Conservation Service Technical Release No. 55, "Urban Hydrology for Small Watersheds," June 1986.

p. SCS National Engineering Handbook, Section 4, Soil Conservation Service, U.S. Department of Agriculture, August 1972.

q. "Climatological Data," National Oceanic and Atmospheric Administration, Environmental Data Service, U.S. Department of Commerce.

r. "Minnesota River At Chaska, Minnesota, Limited Reevaluation Report," August 1982.

s. "Minnesota River At Chaska, Minnesota, Flood Control Project, General Design Memorandum," Revised August 1984.

t. "Minnesota River At Chaska, Minnesota, Flood Control Project, Design Memorandum No. 1, Chaska Creek," December 1984.

u. "Minnesota River At Chaska, Minnesota, Flood Control Project, General Design Memorandum, Supplement No. 1," April 1986.

v. "Flood Control, Minnesota River, Minnesota, Report On Portable Maximum Floods And Standard Project Floods, Minnesota River Basin, Minnesota," January 1971.

w. "Flood Control, Minnesota River, Minnesota, Mankato-North Mankato-LeHllier, Design Memorandum No. 7, Mankato Stage 3C," September 1981.

x. "Design Memorandum And Environmental Assessment, St. Paul Flood Control Project, Mississippi River at St. Paul, Minnesota," March 1990.

y. "Flood Control, Middle River At Argyle, Minnesota, Stage 2," Plans And Specifications.

z. "Hydraulic Charts for the Selection of Highway Culverts," Hydraulic Engineering Circular No. 5, U.S. Department of Transportation, Federal Highway Administration, April 1977.

aa. "Guidelines for Determining Flood Flow Frequencies," Bulletin No. 17B of the Hydrology Committee, March 1982, U.S. Water Resources Council.

bb. "Erosion Control Measures At Storm Sewer And Culvert Outlets," by John L. Grace, Jr., Waterways Experiment Station, Vicksburg, Mississippi.

cc. "Straight Drop Spillway Stilling Basin," by Charles A. Donnelly and

Fred W. Blaisdell, Hydraulic Enginers, USDA, ARS, Technical Paper No. 15, Series B, University Of Minnesota St. Anthony Falls Hydraulic Laboratory, November 1954.

dd. "Flow of Flood Water Over Railway and Highway Embankments," by David L. Yarnell and Floyd A. Nagler, published in "Public Works," April 1930.

TABLE A-1

ACCUMULATED 96-HOUR THEORETICAL RAINFALL AMOUNTS

Rainfall Duration In Hours	Rainfall Frequency In Percent 100	40	20	10	4	2	1	SPS
0.5	0.90	1.23	1.44	1.67	1.89	2.16	2.50	2.90
1.0	1.14	1.51	1.75	2.06	2.32	2.63	3.00	3.66
1.5	1.25	1.68	1.94	2.29	2.58	2.95	3.27	4.38
2.0	1.33	1.81	2.09	2.47	2.79	3.16	3.53	5.10
2.5	1.40	1.90	2.21	2.59	2.94	3.32	3.72	5.80
3.0	1.46	1.98	2.30	2.71	3.06	3.47	3.88	6.44
3.5	1.51	2.05	2.38	2.81	3.18	3.59	3.99	7.02
4.0	1.55	2.11	2.43	2.89	3.28	3.69	4.09	7.59
4.5	1.59	2.17	2.49	2.96	3.37	3.79	4.18	8.14
5.0	1.63	2.23	2.55	3.02	3.45	3.87	4.26	8.64
5.5	1.67	2.28	2.60	3.08	3.51	3.94	4.34	9.12
6.0	1.69	2.33	2.65	3.14	3.57	4.01	4.41	9.60
12.0	1.85	2.60	3.00	3.50	4.10	4.60	5.10	11.15
18.0	2.00	2.85	3.30	3.80	4.50	5.10	5.60	11.71
24.0	2.15	2.95	3.50	4.00	4.75	5.40	5.95	12.10
48.0	2.60	3.50	4.10	4.60	5.60	6.40	7.00	13.50
72.0	2.85	3.80	4.50	5.10	6.15	7.00	7.65	14.10
96.0	3.15	4.15	4.85	5.55	6.60	7.45	8.20	14.30

TABLE A-2

HOURLY INCREMENTAL RAINFALL AMOUNTS

Rainfall Duration In Hours	Rainfall Frequency In Percent 100	40	20	10	4	2	1	SPS	Duration In Hours	SPS
0.167	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	6.167	0.16
0.333	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	6.333	0.16
0.500	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	6.500	0.16
0.667	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	6.667	0.16
0.833	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	6.833	0.16
1.000	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	7.000	0.16
1.167	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	7.167	0.16
1.333	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	7.333	0.17
1.500	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	7.500	0.17
1.667	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	7.667	0.18
1.833	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	7.833	0.18
2.000	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.04	8.000	0.19
2.167	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.04	8.167	0.19
2.333	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	8.333	0.19
2.500	0.02	0.02	0.02	0.03	0.04	0.04	0.03	0.04	8.500	0.19
2.667	0.02	0.02	0.02	0.03	0.04	0.04	0.04	0.04	8.667	0.19
2.833	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.04	8.833	0.19
3.000	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.04	9.000	0.20
3.167	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.05	9.167	0.21
3.333	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.05	9.333	0.21
3.500	0.02	0.03	0.03	0.04	0.04	0.05	0.06	0.05	9.500	0.22
3.667	0.02	0.03	0.04	0.04	0.05	0.05	0.06	0.05	9.667	0.23
3.833	0.02	0.03	0.04	0.04	0.05	0.05	0.06	0.05	9.833	0.24
4.000	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.05	10.000	0.24
4.167	0.03	0.04	0.05	0.06	0.07	0.07	0.08	0.05	10.167	0.24
4.333	0.03	0.04	0.05	0.06	0.07	0.07	0.09	0.05	10.333	0.24
4.500	0.03	0.05	0.05	0.06	0.07	0.07	0.09	0.05	10.500	0.24
4.667	0.03	0.05	0.06	0.07	0.08	0.08	0.09	0.05	10.667	0.24
4.833	0.04	0.06	0.06	0.08	0.09	0.09	0.09	0.05	10.833	0.24
5.000	0.04	0.06	0.07	0.08	0.09	0.10	0.09	0.05	11.000	0.24
5.167	0.07	0.07	0.08	0.10	0.10	0.13	0.13	0.06	11.167	0.25
5.333	0.08	0.09	0.10	0.13	0.14	0.16	0.17	0.06	11.333	0.25
5.500	0.09	0.11	0.13	0.16	0.19	0.23	0.20	0.06	11.500	0.26
5.667	0.20	0.26	0.30	0.36	0.41	0.47	0.51	0.06	11.667	0.61
5.833	0.30	0.41	0.47	0.56	0.63	0.71	0.83	0.07	11.833	0.96
6.000	0.40	0.55	0.66	0.75	0.85	0.98	1.16	0.09	12.000	1.33

TABLE A-3

INCREMENTAL RAINFALL IN 4-2-1-3 DISTRIBUTION

Time In	Rainfall Frequency In Percent									
Hours	100	40	20	10	4	2	1	SPS		SPS
0.167	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	6.167	1.33
0.333	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	6.334	0.61
0.500	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	6.500	0.25
0.667	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	6.667	0.24
0.833	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	6.834	0.24
1.000	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	7.000	0.24
1.167	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.04	7.167	0.24
1.333	0.02	0.02	0.02	0.03	0.04	0.04	0.03	0.04	7.334	0.23
1.500	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.04	7.500	0.21
1.667	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.05	7.667	0.20
1.833	0.02	0.03	0.03	0.04	0.04	0.05	0.06	0.05	7.834	0.19
2.000	0.02	0.03	0.04	0.04	0.05	0.05	0.06	0.05	8.000	0.19
2.167	0.03	0.04	0.05	0.06	0.07	0.07	0.08	0.05	8.167	0.19
2.333	0.03	0.05	0.05	0.06	0.07	0.07	0.09	0.05	8.334	0.18
2.500	0.04	0.06	0.06	0.08	0.09	0.09	0.09	0.05	8.500	0.17
2.667	0.07	0.07	0.08	0.10	0.10	0.13	0.13	0.06	8.667	0.16
2.833	0.09	0.11	0.13	0.16	0.19	0.23	0.20	0.06	8.834	0.16
3.000	0.30	0.41	0.47	0.56	0.63	0.71	0.83	0.07	9.000	0.16
3.167	0.40	0.55	0.66	0.75	0.85	0.98	1.16	0.16	9.167	0.09
3.333	0.20	0.26	0.30	0.36	0.41	0.47	0.51	0.16	9.334	0.06
3.500	0.08	0.09	0.10	0.13	0.14	0.16	0.17	0.16	9.500	0.06
3.667	0.04	0.06	0.07	0.08	0.09	0.10	0.09	0.16	9.667	0.05
3.833	0.03	0.05	0.06	0.07	0.08	0.08	0.09	0.17	9.834	0.05
4.000	0.03	0.04	0.05	0.06	0.07	0.07	0.09	0.18	10.000	0.05
4.167	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.19	10.167	0.05
4.333	0.02	0.03	0.04	0.04	0.05	0.05	0.06	0.19	10.334	0.05
4.500	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.19	10.500	0.05
4.667	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.21	10.667	0.04
4.833	0.02	0.02	0.02	0.03	0.04	0.04	0.04	0.22	10.834	0.04
5.000	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.24	11.000	0.04
5.167	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.24	11.167	0.04
5.333	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.24	11.334	0.03
5.500	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.24	11.500	0.03
5.667	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.25	11.667	0.03
5.833	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.26	11.834	0.02
6.000	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.96	12.000	0.02

TABLE A-4

HISTORICAL RAINFALL WITH 48-HOUR ACCUMULATION OF 3.00 INCHES OR MORE

Year	Day	Q	Precip. Total	Loc.	Start. Hour	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1944	Jun 4	17800	4.28																													
1949	Jul 26	840	0.63	M	1	0.10	0.14	0.01																					0.06			
	Jul 27	1070	4.77	M	3	0.01	0.04	0.05	0.01	0.01	0.08	0.90	1.25	2.49	0.25																	
1951	Jul 21	6060	3.95	M	22	0.27	3.14	0.17	0.37																							
1955	Jul 7	1810	0.37	M	19	0.23	1.31	0.07	0.01	0.24	1.28																					
	Jul 8	3510	4.96	M	1	0.38	1.71	0.09	0.01																							
1956	Aug 2	1820	2.50	M	2	0.01						0.01	0.16	0.12	0.50	0.80	0.05	0.02	0.02	0.04	0.02	0.11	0.16	0.12	0.32	0.27	0.06	0.01				
	Aug 3	2600	1.41	M	2	0.18	0.14	0.04	0.23	0.38	0.02																0.06	0.06				
1957	Jun 22	8660	3.31	L	21	0.85	1.30	0.40	0.15	0.16	0.05	0.03	0.08	0.08		0.01	0.04	0.10	0.01													
	Jun 23	11600	0.20	L	19	0.02	0.12	0.05			0.06																					
1959	Jun 25	962	2.83	M	2	0.12							0.02				0.05		0.02	0.49	1.20	0.75	0.43	0.05	0.02							
	Jun 26	1470	0.78	M	4	0.46																										
1960	May 18	4480	0.13	L	10	0.05		0.03	0.15	0.07	0.02	0.09	0.21	0.15	0.07					0.02												
	May 19	5680	0.68	L	3	0.22	0.39	0.19																			0.17					
	May 20	7780	2.19	L	1	0.05	0.29	0.09	0.02	0.10	0.24												0.34	0.10	0.31	0.64	0.21	0.19	0.02			
	May 21	12100	3.51	L	1	0.30	0.30	0.07	0.47	0.17	0.10	0.03	0.02	0.02	0.31	0.09	0.02	0.09	0.02	0.03	0.02	0.02										
1968	Jun 13-14	4680	3.87	M	9	0.09	0.16	0.63									1.43	1.04	0.52													
1968	Jul 12	1880	0.68	M	4	0.19	1.38	0.20	0.02							0.03								0.02	0.08	0.05						
	Jul 13	2520	1.34	M	1	0.01		0.05	0.17	0.25	0.21	0.07	0.26																0.05			
	Jul 14	4240	2.30	M	1	0.02	0.02					0.89	0.06	0.10	0.01	0.15	0.03															
1978	Jun 15	3840	0.22	M	15	0.24	0.08		0.24	0.24	0.16																					
	Jun 16	3750	1.08	M	5	0.25										0.08		0.97		0.08		0.80	0.08									
	Jun 17	4030	2.00	M	9	0.08																										
1978	Aug 26	1070		M	22	0.03	0.15	0.63																								
	Aug 27	1180	3.51	M	1	0.79	0.80	0.29	0.54	0.19			0.04	0.02	0.01	0.02																
1980	Jun 4	11000		M	19	0.04					0.03																					
	Jun 5	11900	0.38	M	1	0.06	0.02	0.49	0.90	0.15	0.02	0.01										0.11	0.13	0.25								
	Jun 6	12500	1.32																													
	Jun 7	12900	1.69	M	1	0.04	0.85	0.28	0.01																							
1981	Jul 11-12	3920	3.00	L	1	0.29			0.11	1.29	0.50	0.33	0.48																			
1981	Aug 5-7	5720	3.16	M	4	0.78	0.32	0.16	0.16	0.32														1.26	0.16							
1983	Jun 20	10700		M	9	0.30																										
	Jun 21-22	12600	3.12	M	9	2.55	0.27																									
1984	Aug 7-8	6960	5.10	M	24	0.07	0.29	0.11	1.10	0.11	2.31	0.24			0.15	0.33	0.09	0.04						0.02	0.11	0.09	0.04					
1987	Jul 21	3100	7.83	M	19	0.27	2.91	0.49	0.31	0.64	1.05	1.61	0.39	0.16																		
1987	Jul 23-24	2490	3.25	M	20	0.75	0.87	0.84	0.16	0.35	0.28																					
1988	Aug 2			M	9	0.03							0.13	0.22	0.07	0.03																
	Aug 3		0.61	M	3	0.01																		0.64	0.01	0.68	0.18					
	Aug 4-5	-	3.00	M	1	0.04	0.90	0.34	0.15	0.03																			0.03	0.12		

TABLE A-5

HISTORICAL RAINFALLS WITH A DAILY TOTAL OF 0.4 INCHES OR MORE WHICH
OCCURRED DURING OR JUST PRIOR TO A PERIOD OF BLOCKED GRAVITY DRAINAGE

Year	Date	Q	Precip. Total	Loc.	Start. Hour	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1944	May 2	14700	1.16																											
	May 3	15800	1.99																											
	May 4	17400	0.46																											
	May 11	24100	0.78																											
	May 12	23200	0.07																											
	May 17	19000	0.39																											
	May 18	18800	0.45																											
	May 19	19000	0.23																											
	May 31	19300	0.13																											
	Jun 1	18500	0.53																											
	Jun 4	17800	4.28																											
	Jun 5	18800	0.22																											
	Jun 12	16300	0.02																											
	Jun 13	15800	1.11																											
	Jun 23	18000	1.05																											
1947	Apr 22	17400	0.23																											
	Apr 23	17600	0.33																											
	May 1	19700	0.57																											
	May 2	20000	0.40																											
	May 6	19400	0.54																											
	Jul 14	17800	0.76																											
1949	Mar 30	15700	0.29	M	3	0.01	0.03	0.02	0.03	0.01	0.01			0.01							0.01					0.01				
	Mar 31	17900	0.45	M	1	0.03	0.05	0.06	0.03	0.08	0.08	0.10	0.10	0.04	0.03	0.02	0.02													
	Apr 14	19500	0.58	M	1	0.01	0.03			0.05	0.02	0.02	0.05	0.07	0.08	0.08	0.06	0.05	0.04	0.01	0.01									
1951	Apr 20	38700	0.07	M	17	0.04	0.11	0.09	0.08	0.07	0.05	0.03	0.02																	
	Arp 21	34500	0.75	M	1	0.01	0.02	0.01	0.02	0.01	0.02	0.04	0.04	0.02		0.01	0.02	0.03	0.04	0.02	0.01									
	Apr 30	21200	0.11	L	11	0.09			0.04		0.00	0.05						0.22	0.18											
	May 1-2	20500	1.29	L	1	0.04	0.04	0.02						0.32	0.02	0.02				0.20			0.02	0.07	0.09					
	Jul 3	17100	0.43	M	2	0.01	0.14	0.11							0.10															
	Jul 4	19600	0.05	M	5	0.09	0.01	0.01																						
1953	Jun 13	22900	0.89	L	1	0.59	0.30																							
	Aug 11	16100	0.51	M	1	0.17	0.08	0.01	0.04		0.15	0.04											0.02							
1957	Jul 3	21700	1.83	M	5	0.03	1.05	0.45	0.28	0.02																				
1960	Apr 13	18600	1.07	L	17	0.06	0.12	0.18	0.17	0.18	0.25	0.01	0.00	0.01	0.08	0.01														
	May 26	35100	0.57	M	17	0.01	0.01			0.01																				
	May 27	31700	0.25	M	7	0.01	0.16	0.02						0.08	0.13	0.07		0.01			0.01	0.22	0.06							
1962	Jul 15	16500	0.52	M	21	0.06	0.09	0.05	0.06	0.01														0.19	0.03	0.03				
1965	Apr 25-26	32800	0.94	M	1	0.01	0.01	0.02	0.02	0.04	0.06	0.05	0.05	0.02	0.05	0.05	0.05	0.06	0.06	0.12	0.06	0.06	0.06	0.02	0.05	0.01				
	May 5	17500		L	9	0.26	0.03								0.05															
	May 6	16100	0.47	L	21	0.07																								
	May 7	16100	1.48	L	22	0.63	1.25	0.49																						
	May 8	15500	0.61	L	1	0.13	0.16	0.01	0.01	0.01	0.04																	0.12	0.05	
	May 9	16200	1.01	L	1	0.22	0.04																							
	May 31	14800		M	4	0.12	0.05					0.01										0.12	0.10	0.25	0.07	0.13				
	Jun 1	16400	1.30	M	1	0.02	0.07	0.05	0.01	0.05	0.15	0.02	0.02												0.06					
1967	Apr 5	16300		M	17	0.02	0.22	0.24	0.48	0.31	0.07																			
	Apr 6-7	18900	1.38	M	18	0.02			0.02		0.02																			
	Jun 20-21	17100	0.69	L	1	0.13	0.16	0.13	0.04	0.01																				
	Jun 23	17100	0.56	L	5	0.15	0.41																							
1969	Mar 28	16400	0.43	M	1	0.05	0.10	0.11	0.08	0.06	0.02	0.01																		
	Apr 14	84500	0.01	M	18	0.03	0.10	0.07	0.06	0.01	0.03		0.01	0.01	0.01	0.04	0.01	0.03	0.03	0.01										
	Apr 15	83500	0.50	M	13	0.01	0.01																							
	Apr 27	28600	0.55	L	23	0.02	0.02	0.01	0.19	0.19	0.03												0.01	0.01	0.02	0.02	0.02		0.01	0.01

TABLE A-5
(Continued)

HISTORICAL RAINFALLS WITH A DAILY TOTAL OF 0.4 INCHES OR MORE WHICH
OCCURRED DURING OR JUST PRIOR TO A PERIOD OF BLOCKED GRAVITY DRAINAGE

Year	Date	Q	Precip. Total	Loc.	Start. Hour	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1972	Mar 21	16200	0.52	M		0.01		0.01						0.21	0.11	0.01			0.02	0.04	0.08	0.02													
	Jun 14	16800	1.17	M	20	0.47	0.70																												
1975	Apr 26	16100	0.08	M	15	0.02					0.02			0.01																					
	Apr 27	16800	1.46	M	2	0.06		0.13	0.28	0.30	0.02	0.05		0.09	0.45	0.13	0.03	0.02				0.06				0.04	0.06	0.04	0.01						
	Apr 28	17700	0.27	M	21	0.01	0.01																												
	May 7	18900	0.62	M	9	0.01	0.03	0.09	0.26	0.17	0.03	0.04																							
	May 8	18000	0.04	M	13	0.04																													
1979	Apr 12	24900	0.45	L	23	0.04	0.07																												
	Apr 13	24000	0.04	L	1	0.33	0.04	0.01																											
	May 1	19700	0.12	M	15	0.02	0.08	0.01	0.04	0.02	0.04	0.04	0.03	0.07	0.04																				
	May 2	19100	0.53	M	1	0.03	0.08	0.07	0.06	0.01	0.03	0.01																							
	Aug 29	23200	1.54	M	14	0.70	0.18	0.66																											
1983	Mar 5	26100	0.81	M	11	0.01	0.02	0.00	0.01							0.01	0.08	0.12	0.08																
	Mar 6	27600	0.42	M	4	0.01	0.04	0.06	0.11	0.05								0.04	0.56	0.16	0.10	0.01		0.01		0.01									
	Mar 7	28700	0.32	M	10	0.01		0.01															0.01							0.01					
	Mar 16	23400	0.50	M	13	0.01	0.05	0.02	0.02	0.02	0.02	0.02	0.08	0.02	0.02	0.01	0.04	0.05	0.05	0.02		0.02													
	Mar 17	22000	0.04	M	6	0.02	0.04		0.01	0.02	0.02	0.01																							
	Apr 6	21400	0.46	M	1	0.01		0.02	0.05	0.03	0.02	0.09	0.04	0.04	0.05	0.06	0.01	0.03	0.01	0.01										0.01					
	Apr 13	26900	0.85	M	14	0.01	0.06	0.02	0.01	0.01	0.04	0.04	0.05	0.07	0.06	0.01																			
	Apr 14	28000	0.33	M	5	0.01	0.01	0.10	0.07	0.02					0.01	0.01																			
	Apr 15-16	30200	0.25	M	1	0.02	0.02	0.06	0.04	0.08	0.08	0.09	0.09	0.08	0.07	0.09	0.06	0.03	0.02	0.01	0.01														
	May 2	17000	0.81	L	1	0.07	0.11	0.12	0.16	0.13	0.08	0.05		0.03	0.07																				
	May 12-13	21700	0.90	M	1	0.01	0.05										0.01	0.04	0.13	0.10	0.40	0.13	0.02												
	May 18	18900	0.01	M	17	0.01			0.01																										
	May 19-20	17900	0.42	M	2	0.01	0.03	0.02	0.08	0.01	0.04	0.15	0.07																						
	Jul 4	17300	1.43	M	13	1.28	0.15																												
1984	Apr 12	28000	0.45	M	10	0.01	0.04				0.01		0.01			0.01	0.01	0.01	0.01	0.01															
	Apr 13	28000	0.33	M	4	0.02	0.01	0.01		0.04	0.19	0.07	0.08	0.06						0.05					0.01	0.01									
	Apr 14	28100	0.14	M	3	0.02	0.01	0.01	0.04						0.03		0.05	0.01	0.01			0.01	0.01	0.03											
	Apr 15	28100	0.01	M	4	0.01	0.01	0.01	0.02																										
	Apr 26	21200	0.11	M	24	0.05		0.03				0.01																							
	Apr 27-28	20000	0.70	M	21	0.06	0.01				0.08	0.19	0.01		0.10	0.15	0.09			0.02															
	Apr 30	17600	1.33	M	16	0.04	0.13	0.13	0.21	0.12	0.04	0.07	0.10	0.14	0.04	0.10	0.10	0.02	0.04	0.04															
	May 6	23600	0.03	M	23	0.14	0.69																												
	May 7-8	26100	1.07	M	1	0.10	0.03		0.06	0.02	0.03	0.01	0.01	0.02	0.01																				
	Jun 17	18200	0.40	M	9	0.03	0.26	0.10	0.13	0.32																									
	Jun 18	22900	0.69	M	11	0.14	0.03							0.02	0.02		0.05																		
	Jul 10-11	17100	2.64	L	7	0.75	0.18	0.02	0.32	1.03	0.33																								
1985	Mar 31	18600	0.15	M	10	0.01	0.02	0.03	0.02	0.02	0.04	0.03	0.06	0.14	0.11	0.13	0.10	0.06	0.06	0.06															
	Apr 1	18600	0.85	M	1	0.05	0.03	0.02	0.02	0.01																									
	Apr 23	11100	1.10	L	21	0.04	0.20	0.14	0.01	0.01	0.09	0.04	0.01	0.01	0.02	0.04	0.01						0.02	0.01	0.01	0.02	0.01	0.01	0.09	0.07	0.01	0.03	0.08	0.02	
	Apr 24	14200	0.38	L	1	0.01		0.01		0.02	0.10	0.11			0.18	0.02	0.02																		
1986	Apr 3	27500	0.56	L	21	0.02	0.01	0.04	0.11																										
	Apr 4	27100	0.03	L	1	0.12	0.16	0.06	0.05		0.01	0.00	0.04	0.04	0.05																				
	Apr 5	27200	0.69	L	12	0.05	0.30	0.11	0.01	0.01								0.06																	
	Apr 6	27800	0.03	L	1	0.07																													
	Apr 14	32100	1.08	M	4	0.02		0.05	0.13	0.10	0.05	0.01			0.01		0.01						0.02	0.01	0.01	0.01									
	Apr 15	31400	0.19	M	1	0.82																													
	Apr 19	28000	0.50	M	11	0.04	0.06	0.03	0.10	0.16	0.01		0.01			0.06	0.01																		
	Apr 20	27800	0.05	M	20	0.03	0.01																												
	Apr 27	25000	0.52	M	21	0.03		0.34	0.12								0.01	0.08	0.05				0.01	0.05	0.59	0.01				0.07					
	Apr 28-29	26600	1.09	M	1	0.05	0.01	0.10	0.09	0.02																									
	May 10	24900	0.17	M	12	0.06	0.06	0.01	0.01	0.02	0.04	0.10	0.04	0.09	0.10	0.19	0.14	0.14																	
	May 11	23300	1.06	M	1	0.06	0.03	0.03	0.02	0.06	0.02																								
	Jun 21	12000	1.07	M	19	0.01	0.01			0.01	0.36	0.09	0.01	0.0[illegible]																	0.59	0.41	[illegible]	[illegible]37	0.06
	Jun 22	13900	1.45	M	1	0.09	0.18	0.18	0.13	0.01																									
	Jul 2	18500	0.47	L	22	0.47																													

TABLE A-6

INTERIOR WATERSHED CHARACTERISTICS

Section	1	2a	2b	2c	2d	2e	2f	3a	3b	3c	3d	3e	3f	3g
Area in Acres	36.0	10.1	8.7	6.6	9.1	8.7	5.2	8.9	7.5	5.7	15.9	10.5	5.2	7.9
Area in Squrae Miles	0.056	0.0157	0.0136	0.0104	0.0142	0.0136	0.0082	0.0138	0.0118	0.009	0.0248	0.0164	0.0081	0.0124
Max. Elev. - Feet		26	29.5	30	45.5	46	33	46	34.5	30	36.3	25	23	25
Mid Elev.			23	29	29	34		29	33		35	23.5		21
Min. Elev.		10	11	11	12	10	14	11	10	9	7	6	5	9
Length - Feet	2200	810	670	1050	1200	1150	860	1430	1360	990	1910	1150	1030	1340
Slope in Feet/Feet	0.0170	0.0198	0.0276	0.0181	0.0279	0.0313	0.0221	0.0245	0.0180	0.0212	0.0153	0.0165	0.0175	0.0119
Sheet Flow Slope		0.0867	0.0217	0.0100	0.0550	0.0400	0.1100	0.0567	0.0050	0.1000	0.0093	0.0100	0.0767	0.0133
Street Slope		0.0867	0.0324	0.0189	0.0372	0.0424	0.1100	0.0159	0.0217	0.1000	0.0166	0.0190	0.0767	0.0115
Watershed Length in Feet														
Sheet Flow		300	300	100	300	300	300	300	300	300	140	150	300	300
Paved streets		510	370	950	900	850	560	1130	1060	690	1770	1000	730	1040
Manning's n Used for Sheet Flow		0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Two-Year, 24-Hour Rainfall - P2		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Average Velocity, Shallow Concentrated Flow - Fps		4.7	3.6	2.8	3.9	4.2	5.2	2.6	3.0	5.1	2.6	2.8	5.7	2.2
Time of Concentration - Hours														
Sheet Flow		0.329	0.573	0.324	0.395	0.448	0.299	0.390	1.030	0.311	0.437	0.448	0.346	0.696
Shallow Concentrated Flow		0.030	0.029	0.094	0.064	0.056	0.030	0.121	0.098	0.038	0.189	0.099	0.036	0.131
Total		0.359	0.601	0.418	0.459	0.505	0.329	0.511	1.128	0.348	0.626	0.548	0.381	0.827
Total In Minutes		21.6	36.1	25.1	27.5	30.3	19.7	30.6	67.7	20.9	37.6	32.9	22.9	49.6
Lag Time in Hours	0.340	0.216	0.361	0.251	0.275	0.303	0.197	0.306	0.677	0.209	0.376	0.329	0.229	0.496
Ratio of Impervious	0.30	0.35	0.35	0.35	0.35	0.35	0.35	0.45	0.45	0.45	0.45	0.45	0.45	0.45
SCS Curve Number (Antecedent Moisture Condition II)	93	81	81	81	81	81	81	83	83	83	83	83	83	83

TABLE A-7

UNIT HYDROGRAPHS

Time In Hours	10-Minute Unit Hydrographs Section: 1	2a	2b	2c	2d	2e	2f	Total Section 2	3a	3b	3c	3d	3e	3f	3g	Total Section 3	60-Minute Unit Hydrographs Section 2	Section 3
0.167	19	15	4	7	8	6	9	49	6	1	9	7	6	7	2	38	8	6
0.333	59	25	13	15	19	16	13	101	17	3	14	22	18	12	6	92	25	22
0.500	61	12	14	10	15	15	6	72	15	6	7	26	18	7	10	89	37	37
0.667	38	5	10	4	7	8	2	36	8	7	3	19	10	3	10	60	43	47
0.833	19	2	5	2	3	4	1	17	4	7	1	10	5	1	8	36	46	53
1.000	10	1	3	1	2	2	0	9	2	6	0	6	3	1	5	23	47	56
1.167	5	0	2	0	1	1		4	1	5		3	1	0	3	13	40	52
1.333	3		1		0	0		1	0	3		2	1		2	8	23	38
1.500	1		0					0		2		1	0		1	4	11	24
1.667	1									2		1			1	4	5	14
1.833	0									1		0			0	1	2	9
2.000										1						1	1	5
2.167										1						1	0	3
2.333										0						0		2
2.500																		1
2.667																		1
2.833																		0

TABLE A-8

RUNOFF HYDROGRAPHS

100 - Percent Event

Hours	2a	2b	2c	2d	2e	2f	Total	3a	3b	3c	3d	3e	3f	3g	Total	Combined Runoff
0.167	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
0.333	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	3
0.500	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	3
0.667	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	3
0.833	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2
1.000	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2
1.167	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2
1.333	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2	2
1.500	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2	2
1.667	1	0	0	0	0	0	1	0	0	0	1	0	0	1	2	3
1.833	1	0	0	1	0	0	2	1	0	0	1	1	0	1	4	6
2.000	1	1	0	1	1	0	4	1	0	0	1	1	0	1	4	8
2.167	1	1	0	1	1	0	4	1	0	0	1	1	0	1	4	8
2.333	1	1	0	1	1	0	5	1	0	0	1	1	0	1	4	9
2.500	1	1	0	1	1	0	4	1	0	0	1	1	0	1	4	8
2.667	1	1	1	1	1	0	5	1	1	1	1	1	1	1	7	12
2.833	1	1	1	1	1	1	6	1	1	1	2	1	1	1	8	14
3.000	3	1	2	2	2	2	12	2	1	2	3	3	2	1	14	26
3.167	7	3	4	5	4	4	27	5	2	5	7	6	4	3	32	59
3.333	9	6	6	7	7	5	40	8	3	6	12	9	6	4	48	88
3.500	7	7	5	7	7	4	37	8	4	5	14	10	5	6	52	89
3.667	5	6	4	5	5	2	27	6	5	3	12	8	3	6	43	70
3.833	3	4	2	3	3	1	16	4	5	2	9	5	2	5	32	48
4.000	2	3	2	2	2	1	12	3	4	1	6	3	1	4	22	34
4.167	1	2	1	2	2	1	9	2	4	1	4	2	1	3	17	26
4.333	1	1	1	1	1	0	5	1	3	1	3	2	1	2	13	18
4.500	1	1	1	1	1		5	1	2	1	3	2	1	2	12	17
4.667	1	1	1	1	1		5	1	2	1	2	1	1	1	9	14
4.833	1	1	0	1	1		4	1	2	1	2	1	1	1	9	13
5.000	1	1		1	1		4	1	1	1	2	1	1	1	8	12
5.167	1	1		1	1		4	1	1	1	2	1	1	1	8	12
5.333	1	1		1	1		4	1	1	1	2	1	0	1	7	11
5.500	1	1		1	1		4	1	1	0	1	1		1	5	9
5.667	1	1		1	1		4	1	1		1	1		1	5	9
5.833	1	1		1	1		4	1	1		1	1		1	5	9
6.000	1	1		1	1		4	1	1		1	1		1	5	9
6.167	1	1		1	1		5	1	1		1	1		1	5	10
6.333	0	0		0	0		0	0	1		1	0		0	2	2
6.500									0		0				0	0

TABLE A-9

RUNOFF HYDROGRAPHS

40 - Percent Event

Hours	2a	2b	2c	2d	2e	2f	Total	3a	3b	3c	3d	3e	3f	3g	Total	Combined Runoff
0.167	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
0.333	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	3
0.500	1	0	0	0	0	0	2	0	0	0	1	0	0	0	3	5
0.667	1	0	0	1	0	0	3	1	0	0	1	1	0	0	3	6
0.833	1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.000	1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.167	1	1	0	1	1	0	3	1	0	0	1	1	0	0	4	6
1.333	1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	6
1.500	1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	7
1.667	1	1	0	1	1	0	3	1	0	0	1	1	0	1	3	6
1.833	1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	7
2.000	1	1	0	1	1	0	4	1	0	0	1	1	0	1	4	8
2.167	1	1	0	1	1	0	4	1	1	0	1	1	0	1	5	9
2.333	1	1	1	1	1	0	6	1	1	1	1	1	1	1	8	14
2.500	1	1	1	1	1	1	6	1	1	1	2	1	1	1	8	15
2.667	1	1	1	1	1	1	6	1	1	1	2	1	1	1	8	14
2.833	2	1	1	1	1	1	7	2	1	1	3	2	1	1	11	18
3.000	4	2	2	3	2	3	16	3	1	3	5	4	3	2	21	37
3.167	11	5	6	7	6	6	41	8	2	8	11	9	6	4	48	89
3.333	14	9	9	12	10	8	62	12	4	10	19	14	8	7	74	136
3.500	11	10	8	11	10	6	56	12	6	7	21	14	7	9	76	132
3.667	7	9	5	8	8	3	40	9	7	4	18	11	4	9	62	102
3.833	5	6	3	5	5	2	26	6	7	3	13	8	3	8	48	74
4.000	3	4	2	4	4	2	19	4	7	2	9	5	2	6	35	54
4.167	2	3	2	3	3	1	14	3	6	1	6	4	1	4	25	39
4.333	2	2	1	2	2	1	10	2	4	1	5	3	1	3	19	29
4.500	1	2	1	1	2	1	8	2	4	1	4	2	1	3	17	25
4.667	1	1	1	1	1	1	6	2	3	1	3	2	1	2	14	20
4.833	1	1	1	1	1	1	6	1	2	1	3	2	1	2	12	18
5.000	1	1	1	1	1	1	6	1	2	1	3	2	1	2	12	18
5.167	1	1	1	1	1	1	6	1	2	1	2	1	1	1	9	15
5.333	1	1	1	1	1	1	6	1	2	1	2	1	1	1	9	15
5.500	1	1	1	1	1	1	6	1	1	1	2	1	1	1	8	14
5.667	1	1	1	1	1	1	6	1	1	1	2	1	1	1	8	14
5.833	1	1	1	1	1	1	6	1	1	1	2	1	1	1	8	14
6.000	1	1	1	1	1	1	6	1	1	1	2	1	1	1	8	14
6.167	1	1	1	1	1	0	6	1	1	1	2	1	1	1	8	14
6.333	0	1	0	1	1		3	1	1	0	1	1	0	1	6	8
6.500		0		0	0		1	0	1		1	0		1	3	4
6.667							0		1		0			0	1	1
6.833									0						0	0

TABLE A-10

RUNOFF HYDROGRAPHS

20 - Percent Event

Hours	1	2a	2b	2c	2d	2e	2f	Total	3a	3b	3c	3d	3e	3f	3g	Total	Combined Total
0.167		0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
0.333		0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	3
0.500		1	0	0	0	0	0	2	0	0	0	1	0	0	0	2	5
0.667		1	0	0	1	0	0	3	1	0	0	1	1	0	0	3	5
0.833		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.000		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.167		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.333		1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	6
1.500		1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	6
1.667		1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	6
1.833		1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	6
2.000		1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	7
2.167		1	1	1	1	1	0	4	1	1	1	1	1	1	1	5	9
2.333		1	1	1	1	1	1	4	1	1	1	2	1	1	1	6	10
2.500		1	1	1	1	1	1	5	1	1	1	2	1	1	1	7	12
2.667		1	1	1	1	1	1	6	1	1	1	2	2	1	1	9	14
2.833		2	1	1	2	1	1	8	2	1	2	3	2	1	1	12	20
3.000	0	5	3	3	4	3	3	21	4	1	4	6	4	3	2	25	46
3.167	1	14	6	8	9	8	8	53	10	3	9	13	10	8	4	57	110
3.333	2	18	11	11	15	13	10	78	15	5	12	23	17	10	8	89	167
3.500	3	14	13	10	14	13	7	70	15	7	9	26	18	8	11	92	163
3.667	3	9	11	7	9	10	4	49	11	8	5	22	13	5	11	75	124
3.833	2	6	8	4	6	6	3	33	7	9	3	16	9	3	9	56	89
4.000	1	4	5	3	4	5	2	23	5	8	2	11	6	2	7	42	64
4.167	1	3	4	2	3	3	1	17	4	7	2	8	5	2	5	31	48
4.333	0	2	3	2	2	3	1	13	3	5	1	6	3	1	4	24	37
4.500		2	2	1	2	2	1	10	2	4	1	5	3	1	3	19	29
4.667		2	2	1	2	2	1	8	2	3	1	4	2	1	3	16	24
4.833		1	2	1	1	1	1	7	2	3	1	3	2	1	2	14	21
5.000		1	1	1	1	1	1	6	1	2	1	3	2	1	2	12	18
5.167		1	1	1	1	1	1	6	1	2	1	3	2	1	2	10	16
5.333		1	1	1	1	1	1	6	1	2	1	2	1	1	1	9	15
5.500		1	1	1	1	1	1	6	1	2	1	2	1	1	1	9	14
5.667		1	1	1	1	1	1	6	1	1	1	2	1	1	1	8	14
5.833		1	1	1	1	1	1	6	1	1	1	2	1	1	1	8	14
6.000		1	1	1	1	1	1	6	1	1	1	2	1	1	1	8	14
6.167		1	1	1	1	1	0	5	1	1	1	2	1	1	1	7	12
6.333		0	1	0	1	1		3	1	1	0	1	1	0	1	5	8
6.500			0		0	0		1	0	1		1	0		1	3	4
6.667								0		1		0			0	1	1
6.833								0		1						1	1
7.000										0						0	0
7.167																	

TABLE A-11

RUNOFF HYDROGRAPHS

10 - Percent Event

Hours	1	2a	2b	2c	2d	2e	2f	Total	3a	3b	3c	3d	3e	3f	3g	Total	Combined Total
0.167		0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
0.333		0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	3
0.500		1	0	0	0	0	0	2	0	0	0	1	0	0	0	2	5
0.667		1	0	0	1	0	0	3	1	0	0	1	1	0	0	3	5
0.833		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.000		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.167		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.333		1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	6
1.500		1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	6
1.667		1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	7
1.833		1	1	0	1	1	0	3	1	1	1	1	1	1	1	5	8
2.000		1	1	0	1	1	0	3	1	1	1	2	1	1	1	6	9
2.167		1	1	1	1	1	0	4	1	1	1	2	1	1	1	7	10
2.333		1	1	1	1	1	1	4	1	1	1	2	1	1	1	8	12
2.500		1	1	1	1	1	1	6	2	1	1	3	2	1	1	10	15
2.667		2	1	1	1	1	1	8	2	1	1	3	2	1	1	12	19
2.833		3	2	2	2	2	1	11	2	1	2	4	3	2	2	15	26
3.000		7	3	4	5	4	4	28	5	2	5	7	6	4	3	32	60
3.167		17	8	10	12	10	10	67	12	3	12	17	13	10	6	72	139
3.333		22	14	14	18	16	12	97	19	6	14	28	21	13	10	110	206
3.500	0	17	16	12	17	16	9	88	18	9	11	32	22	10	13	114	202
3.667	1	11	13	8	12	12	5	61	13	11	6	27	17	6	14	94	155
3.833	3	7	10	5	8	8	3	41	9	11	4	19	11	4	12	69	110
4.000	5	5	7	4	5	6	2	28	6	10	3	14	8	3	9	51	80
4.167	4	4	5	3	4	4	2	21	4	8	2	10	6	2	7	38	59
4.333	3	3	4	2	3	3	1	15	3	7	2	7	4	2	5	30	45
4.500	3	2	3	2	2	2	1	12	3	5	2	6	3	1	4	24	36
4.667	2	2	2	1	2	2	1	10	2	4	1	5	3	1	3	20	30
4.833	1	2	2	1	2	2	1	9	2	4	1	4	3	1	3	17	26
5.000	0	2	2	1	2	2	1	9	2	3	1	4	2	1	2	15	24
5.167		2	2	1	2	2	1	9	2	3	1	3	2	1	2	14	22
5.333		2	2	1	2	2	1	8	2	2	1	3	2	1	2	12	21
5.500		1	1	1	1	1	1	7	1	2	1	3	2	1	2	11	18
5.667		1	1	1	1	1	1	7	1	2	1	2	2	1	1	10	16
5.833		1	1	1	1	1	1	6	1	2	1	2	1	1	1	9	15
6.000		1	1	1	1	1	1	6	1	1	1	2	1	1	1	8	14
6.167		1	1	1	1	1	0	5	1	1	1	2	1	1	1	7	12
6.333		0	1	0	1	1		3	1	1	0	1	1	0	1	5	8
6.500			0		0	0		1	0	1		1	0		1	3	4
6.667								0		1		1			0	2	2
6.833								0		1		0				1	1
7.000										0						0	0
7.167																	

TABLE A-12

RUNOFF HYDROGRAPHS

4 - Percent Event

Hours	1	2a	2b	2c	2d	2e	2f	Total	3a	3b	3c	3d	3e	3f	3g	Total	Combined Total
0.167		0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
0.333		0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	3
0.500		1	0	0	0	0	0	2	0	0	0	1	0	0	0	2	5
0.667		1	0	0	1	0	0	3	1	0	0	1	1	0	0	3	5
0.833		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.000		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.167		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.333		1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	6
1.500		1	1	0	1	1	0	3	1	0	1	1	1	1	1	5	8
1.667		1	1	0	1	1	0	3	1	1	1	2	1	1	1	7	10
1.833		1	1	0	1	1	0	3	1	1	1	2	1	1	1	6	9
2.000		1	1	1	1	1	0	3	1	1	1	2	1	1	1	6	9
2.167		1	1	1	1	1	1	4	1	1	1	2	1	1	1	7	11
2.333		1	1	1	1	1	1	4	1	1	1	2	2	1	1	9	13
2.500		2	1	1	1	1	1	6	2	1	1	3	2	1	1	10	16
2.667		2	2	1	2	2	1	10	2	1	2	3	2	1	1	12	22
2.833		3	2	2	3	2	2	13	3	1	2	5	3	2	2	17	30
3.000		9	4	5	6	5	5	34	6	2	6	9	7	5	3	38	72
3.167		21	10	12	15	12	12	82	14	4	14	20	16	11	7	86	168
3.333		26	17	17	22	19	14	115	22	7	17	33	25	15	12	131	246
3.500		20	19	15	20	19	10	103	21	10	12	37	25	12	16	133	236
3.667		13	16	10	14	14	6	73	15	12	7	31	19	7	16	107	180
3.833		8	11	6	9	9	4	47	10	13	5	22	13	5	13	81	128
4.000	0	6	8	4	6	7	3	34	7	12	3	16	9	3	10	60	94
4.167	2	4	6	3	5	5	2	25	5	10	2	11	7	2	8	45	70
4.333	5	3	4	2	3	4	2	18	4	8	2	9	5	2	6	36	54
4.500	8	3	3	2	3	3	1	15	3	6	2	7	4	2	5	28	43
4.667	6	2	3	2	2	2	1	12	3	5	2	6	3	1	4	24	36
4.833	5	2	2	1	2	2	1	10	2	4	1	5	3	1	3	19	29
5.000	4	2	2	1	2	2	1	9	2	4	1	4	3	1	3	18	27
5.167	2	2	2	1	2	2	1	9	2	3	1	4	2	1	2	15	24
5.333	1	2	2	1	2	2	1	9	2	3	1	3	2	1	2	13	22
5.500	0	2	2	1	2	2	1	10	2	2	1	3	2	1	2	12	21
5.667		2	2	1	2	2	1	10	2	2	1	3	2	1	2	12	21
5.833		1	1	1	1	1	1	6	1	2	1	3	2	1	2	11	17
6.000		1	1	1	1	1	1	6	1	2	1	2	2	1	1	10	16
6.167		1	1	1	1	1	1	6	1	1	1	2	1	1	1	7	13
6.333		0	1	0	1	1	0	3	1	1	0	2	1	0	1	6	8
6.500			1		0	0		2	0	1		1	1		1	4	5
6.667			0					0		1		1	0		1	2	2
6.833								0		1		0			0	1	1
7.000										0						0	0
7.167																	

TABLE A-13

RUNOFF HYDROGRAPHS

2 - Percent Event

Hours	1	2a	2b	2c	2d	2e	2f	Total	3a	3b	3c	3d	3e	3f	3g	Total	Combined Total
0.167		0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
0.333		0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	3
0.500		1	0	0	0	0	0	2	0	0	0	1	0	0	0	2	4
0.667		1	0	0	1	0	0	3	1	0	0	1	1	0	0	3	5
0.833		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.000		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.167		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.333		1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	6
1.500		1	1	0	1	1	0	3	1	0	1	1	1	1	1	5	8
1.667		1	1	1	1	1	0	4	1	1	1	2	1	1	1	6	10
1.833		1	1	1	1	1	1	4	1	1	1	2	1	1	1	7	11
2.000		1	1	1	1	1	1	5	1	1	1	2	1	1	1	7	12
2.167		1	1	1	1	1	1	6	1	1	1	2	1	1	1	8	13
2.333		1	1	1	1	1	1	6	1	1	1	2	2	1	1	9	15
2.500		2	1	1	1	1	1	8	2	1	1	3	2	1	1	11	19
2.667		2	2	2	2	2	1	11	2	1	2	4	3	2	2	15	26
2.833		4	2	2	3	3	2	17	4	2	3	5	4	3	2	23	39
3.000		11	5	6	7	6	6	42	8	3	8	11	8	6	4	46	88
3.167		25	12	14	18	15	14	98	17	5	16	24	19	13	8	101	199
3.333		32	20	20	26	23	17	138	26	8	20	39	29	17	14	152	290
3.500		24	23	17	24	23	12	123	25	12	15	44	30	14	18	157	280
3.667		15	19	11	16	17	7	85	18	15	9	37	23	8	19	127	211
3.833		9	13	7	10	11	4	55	12	15	5	26	15	5	16	93	148
4.000	0	6	9	5	7	7	3	37	8	14	3	18	10	3	12	67	104
4.167	2	5	6	3	5	5	2	27	6	11	3	13	7	2	9	50	76
4.333	5	4	5	3	4	4	2	20	4	9	2	9	5	2	7	38	58
4.500	9	3	4	2	3	3	1	16	3	7	2	7	4	2	5	31	47
4.667	8	3	3	2	3	3	1	14	3	6	2	6	4	2	4	26	40
4.833	7	3	3	2	2	2	1	13	3	5	2	5	3	1	3	22	34
5.000	6	2	2	2	2	2	1	12	2	4	1	5	3	1	3	19	30
5.167	4	2	2	1	2	2	1	10	2	3	1	4	2	1	2	16	27
5.333	2	2	2	1	2	2	1	10	2	3	1	4	2	1	2	15	24
5.500	0	2	2	1	2	2	1	9	2	2	1	3	2	1	2	13	22
5.667		2	2	1	2	2	1	9	2	2	1	3	2	1	2	13	22
5.833		2	2	1	2	2	1	8	2	2	1	3	2	1	2	12	20
6.000		1	1	1	1	1	1	7	1	2	1	3	2	1	1	11	18
6.167		1	1	1	1	1	1	6	1	2	1	2	1	1	1	9	15
6.333		0	1	0	1	1	0	3	1	1	0	2	1	0	1	6	9
6.500			1		0	0		1	0	1		1	1		1	4	5
6.667			0					0		1		1	0		1	2	2
6.833								0		1		0			0	1	1
7.000										0						0	0

TABLE A-14

RUNOFF HYDROGRAPHS

1 - Percent Event

Hours	1	2a	2b	2c	2d	2e	2f	Total	3a	3b	3c	3d	3e	3f	3g	Total	Combined Total
0.167		0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
0.333		0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	3
0.500		1	0	0	0	0	0	2	0	0	0	1	0	0	0	2	5
0.667		1	0	0	1	0	0	3	1	0	0	1	1	0	0	3	5
0.833		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.000		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.167		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.333		1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	6
1.500		1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	7
1.667		1	1	1	1	1	0	4	1	1	1	1	1	1	1	5	9
1.833		1	1	1	1	1	1	4	1	1	1	2	1	1	1	6	11
2.000		1	1	1	1	1	1	5	1	1	1	2	1	1	1	8	13
2.167		1	1	1	1	1	1	6	2	1	1	2	2	1	1	9	15
2.333		2	1	1	1	1	1	8	2	1	1	3	2	1	1	12	19
2.500		2	2	1	2	2	1	9	2	1	2	4	3	1	2	14	23
2.667		3	2	2	2	2	1	12	3	1	2	4	3	2	2	17	29
2.833		4	3	2	3	3	2	17	4	2	3	6	4	2	2	23	39
3.000		12	5	6	8	7	7	45	8	3	8	11	9	7	4	49	94
3.167		29	14	16	20	17	17	113	19	5	19	27	21	16	9	115	228
3.333		37	24	23	31	27	20	162	30	9	23	45	34	20	16	177	339
3.500		28	26	20	28	27	14	142	29	14	17	51	34	16	21	181	323
3.667		16	21	13	18	19	8	95	21	17	10	42	26	10	21	146	241
3.833		10	15	8	11	12	5	60	13	17	6	29	17	6	18	105	165
4.000	0	7	10	5	8	8	3	41	9	15	4	20	11	4	13	76	117
4.167	2	5	7	4	6	6	3	31	6	13	3	14	8	3	10	57	88
4.333	5	4	6	3	5	5	2	24	5	10	3	11	6	2	7	44	68
4.500	10	4	4	3	4	4	2	19	4	8	2	9	5	2	6	35	55
4.667	10	3	4	2	3	3	2	16	3	6	2	7	4	2	5	29	45
4.833	9	3	3	2	3	3	1	14	3	5	2	6	4	1	4	24	38
5.000	8	2	3	2	2	2	1	12	2	4	1	5	3	1	3	20	33
5.167	5	2	2	1	2	2	1	11	2	4	1	4	3	1	3	17	28
5.333	2	2	2	1	2	2	1	10	2	3	1	4	2	1	2	15	25
5.500	0	2	2	1	2	2	1	9	2	3	1	3	2	1	2	14	23
5.667		2	2	1	2	2	1	9	2	2	1	3	2	1	2	13	22
5.833		2	2	1	2	2	1	9	2	2	1	3	2	1	2	12	21
6.000		2	2	1	2	2	1	8	2	2	1	3	2	1	2	11	20
6.167		1	1	1	1	1	1	6	1	2	1	3	2	1	1	9	16
6.333		1	1	0	1	1	0	3	1	1	0	2	1	0	1	7	10
6.500		0	1		0	0		1	0	1		1	1		1	4	5
6.667			0					0		1		1	0		1	2	3
6.833								0		1		0			0	1	1
7.000										0						0	0

TABLE A-15

RUNOFF HYDROGRAPHS FOR HISTORICAL EVENTS

(Gravity Conditions)

Location:	Section 1 - Total Runoff				Section 1 - Runoff To Section 2				Section 2				Section 3			
Event:	July 27 1949	July 21 1951	June 21 1983	July 21 1987	July 27 1949	July 21 1951	June 21 1983	July 21 1987	July 27 1949	July 21 1951	June 21 1983	July 21 1987	July 27 1949	July 21 1951	June 21 1983	July 21 1987
0.167	0	0	4	1	0	0	0	0	0	0	3	1	0	0	1	1
0.333	0	1	17	2	0	0	0	0	0	1	13	2	0	1	6	1
0.500	0	2	37	3	0	0	0	0	0	2	27	4	0	1	15	3
0.667	1	3	55	3	0	0	2	0	1	3	43	4	0	3	29	4
0.833	1	3	68	3	0	0	6	0	1	4	58	4	0	4	47	5
1.000	1	4	76	10	0	0	8	0	1	4	71	7	1	5	64	7
1.167	2	10	75	29	0	0	9	0	2	8	76	20	1	7	79	13
1.333	5	32	57	54	0	0	8	0	5	22	65	40	3	14	86	25
1.500	10	58	36	73	0	2	5	7	8	43	46	61	6	27	83	42
1.667	15	79	24	85	0	7	0	9	11	66	31	79	10	46	73	63
1.833	19	91	17	92	0	10		10	14	86	22	93	14	69	60	84
2.000	22	99	14	89	0	12		12	16	102	17	97	18	92	47	101
2.167	25	95	11	69	0	12		10	19	105	13	84	23	109	37	109
2.333	29	70	7	47	0	11		8	24	88	10	63	27	117	30	105
2.500	34	42	4	33	0	8		3	29	61	6	44	32	111	23	94
2.667	37	25	2	26	0	2		0	34	38	3	34	37	96	18	79
2.833	39	16	1	22	0	0			38	26	2	28	43	77	13	64
3.000	41	12	1	19	2				41	18	1	25	48	59	9	53
3.167	46	9	0	17	3				46	14	1	21	53	44	7	45
3.333	58	10		14	5				59	13	0	18	61	35	5	39
3.500	71	12		13	7				74	14		15	71	29	3	34
3.667	79	12		12	9				86	14		14	84	26	2	30
3.833	83	13		11	10				95	14		13	98	25	2	27
4.000	86	13		12	10				101	15		13	110	24	1	25
4.167	80	12		16	10				99	14		17	117	23	1	24
4.333	60	8		19	9				81	11		21	117	22	1	25
4.500	38	5		21	6				57	7		24	108	19	0	27
4.667	24	2		22	0				38	4		26	92	15		29
4.833	17	1		23					27	2		27	74	12		31
5.000	13	1		24					20	1		29	58	8		33
5.167	10	0		28					16	1		33	44	6		35
5.333	7			33					11	0		39	35	4		39
5.500	4			35					7			43	27	3		43
5.667	2			37					4			45	20	2		48
5.833	1			37					2			47	15	1		52
6.000	0			39					1			49	11	1		55
6.167				45					1			54	7	1		59
6.333				51					0			61	5	1		65
6.500				55								67	4	0		71
6.667				57								71	3			77
6.833				57								73	2			83
7.000				54								70	1			86
7.167				42								59	1			84
7.333				30								45	1			78
7.500				22								34	0			68
7.667				18								27				58
7.833				16								24				48
8.000				14								21				41
8.167				12								18				35
8.333				9								14				30
8.500				7								11				25
8.667				7								10				21
8.833				6								9				18
9.000				5								8				15
9.167				4								6				13
9.333				2								4				11
9.500				1								2				8
9.667				1								1				6
9.833				0								1				4
10.000												0				3
10.167																2
10.333																1
10.500																1
10.667																1
10.833																0

TABLE A-16

RUNOFF HYDROGRAPHS

Standard Project Storm

Hours	1	2a	2b	2c	2d	2e	2f	Total	3a	3b	3c	3d	3e	3f	3g	Total	Combined Total
0.167		0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
0.333		0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	3
0.500		1	0	0	0	0	0	2	0	0	0	1	0	0	0	2	5
0.667		1	0	0	1	0	0	3	1	0	0	1	1	0	0	3	5
0.833		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.000		1	1	0	1	1	0	3	1	0	0	1	1	0	0	3	6
1.167		1	1	0	1	1	0	3	1	0	0	1	1	0	1	4	7
1.333		1	1	0	1	1	0	3	1	0	1	1	1	1	1	5	8
1.500		1	1	0	1	1	0	3	1	1	1	2	1	1	1	6	9
1.667		1	1	1	1	1	0	4	1	1	1	2	1	1	1	7	10
1.833		1	1	1	1	1	1	4	1	1	1	2	1	1	1	7	11
2.000		1	1	1	1	1	1	5	1	1	1	2	1	1	1	7	12
2.167		1	1	1	1	1	1	6	1	1	1	2	1	1	1	7	13
2.333		1	1	1	1	1	1	6	1	1	1	2	1	1	1	7	13
2.500		1	1	1	1	1	1	6	1	1	1	2	1	1	1	8	14
2.667		1	1	1	1	1	1	6	1	1	1	2	2	1	1	9	15
2.833		2	1	1	1	1	1	7	1	1	1	3	2	1	1	10	17
3.000		2	1	1	2	1	1	8	2	1	1	3	2	1	1	11	19
3.167		3	2	2	2	2	1	11	2	1	2	4	2	2	2	14	25
3.333		4	2	2	3	3	2	17	3	2	3	5	4	2	2	21	38
3.500		5	3	3	4	4	3	22	5	2	3	7	5	3	3	28	50
3.667		6	4	4	5	4	3	26	5	3	4	9	6	3	4	33	59
3.833		6	5	4	5	5	3	28	6	3	4	10	7	4	4	38	66
4.000		7	5	4	6	6	4	32	6	4	4	11	7	4	5	42	74
4.167		8	6	5	7	6	4	35	7	5	5	12	8	4	6	46	81
4.333		8	7	5	7	7	4	38	7	5	5	13	9	5	6	50	88
4.500		9	7	6	8	7	5	41	8	5	5	14	9	5	6	53	94
4.667		9	8	6	8	8	5	43	8	6	6	15	10	5	7	56	100
4.833		10	8	7	9	8	5	47	9	6	6	16	10	5	7	60	107
5.000		11	9	7	9	9	6	51	10	7	7	17	11	6	8	64	115
5.167		12	9	8	10	10	6	55	10	7	7	18	12	6	8	69	124
5.333		12	10	8	11	10	7	58	11	8	7	19	13	7	9	74	132
5.500		13	11	8	11	11	7	60	11	8	8	20	13	7	10	77	136
5.667	0	13	11	8	12	11	7	61	12	9	8	21	14	7	10	79	140
5.833	1	13	11	9	12	11	7	63	12	9	8	21	14	7	10	82	145
6.000	2	23	14	14	17	16	13	97	16	10	14	27	19	12	12	109	206
6.167	3	45	24	26	33	29	25	182	30	13	27	44	33	23	17	186	368
6.333	4	53	36	34	45	40	28	235	42	17	31	65	47	27	25	254	489
6.500	5	39	38	28	39	38	19	200	39	22	22	70	47	21	30	251	451
6.667	7	25	31	19	27	28	12	141	28	25	14	58	36	14	30	205	346
6.833	10	18	23	13	19	20	9	103	21	25	10	44	26	10	26	161	264

6.500	5	39	38	28	39	38	19	200	39	22	22	70	47	21	30	251	451
6.667	7	25	31	19	27	28	12	141	28	25	14	58	36	14	30	205	346
6.833	10	18	23	13	19	20	9	103	21	25	10	44	26	10	26	161	264
7.000	13	16	18	11	16	16	8	84	16	23	9	34	20	8	21	131	216
7.167	13	15	15	10	14	14	8	75	14	20	8	29	18	8	17	113	189
7.333	13	14	14	10	13	13	7	71	13	17	8	26	16	7	15	102	173
7.500	13	13	13	9	13	12	7	67	12	15	8	24	15	7	13	94	161
7.667	11	12	12	8	12	11	6	62	12	14	7	22	14	7	12	88	151
7.833	9	12	11	8	11	11	6	59	11	13	7	21	14	6	11	83	142
8.000	8	11	11	8	10	10	6	56	11	12	7	20	13	6	11	79	134
8.167	6	11	10	7	10	10	6	54	10	11	7	19	12	6	10	76	130
8.333	3	11	10	7	10	10	6	53	10	10	7	19	12	6	10	73	127
8.500	0	11	10	7	10	9	6	52	10	10	6	18	12	6	10	71	123
8.667		10	9	7	10	9	5	51	9	9	6	18	11	5	9	68	119
8.833		10	9	7	9	9	5	49	9	9	6	17	11	5	9	65	114
9.000		10	9	7	9	9	5	48	9	9	6	16	11	5	8	63	111
9.167		9	8	6	8	8	4	44	8	8	5	15	10	5	8	59	103
9.333		7	7	5	7	7	3	35	7	8	4	13	8	4	7	51	86
9.500		5	6	4	5	5	2	27	5	7	3	11	7	3	6	41	68
9.667		4	5	3	4	4	2	22	4	6	2	9	5	2	5	34	55
9.833		3	4	2	3	3	2	18	4	5	2	7	4	2	4	28	46
10.000		3	3	2	3	3	2	16	3	5	2	6	4	2	4	25	41
10.167		3	3	2	3	3	2	16	3	4	2	6	4	2	3	22	38
10.333		3	3	2	3	3	2	15	3	3	2	5	3	2	3	21	36
10.500		3	3	2	3	3	2	15	3	3	2	5	3	2	3	20	35
10.667		3	3	2	3	3	2	14	3	3	2	5	3	2	3	19	33
10.833		3	3	2	3	2	1	13	2	3	2	5	3	1	2	18	31
11.000		3	2	2	2	2	1	12	2	3	1	4	3	1	2	17	29
11.167		2	2	2	2	2	1	12	2	2	1	4	3	1	2	16	28
11.333		2	2	2	2	2	1	11	2	2	1	4	3	1	2	15	27
11.500		2	2	1	2	2	1	10	2	2	1	4	2	1	2	14	24
11.667		2	2	1	2	2	1	10	2	2	1	3	2	1	2	13	23
11.833		2	2	1	2	2	1	9	2	2	1	3	2	1	2	12	21
12.000		1	2	1	1	1	1	7	1	2	1	3	2	1	2	11	18
12.167		1	1	1	1	1	1	6	1	2	1	2	1	1	1	9	14
12.333		1	1	0	1	1	0	3	1	1	0	2	1	0	1	6	9
12.500		0	1		0	0		1	0	1		1	1		1	4	5
12.667			0					0		1		1	0		1	2	2
12.833								0		1		0			0	1	1
13.000										1						1	1
13.167										0						0	0

2

Table A-17

RUNOFF HYDROGRAPHS FOR HISTORICAL EVENTS WITH SIGNIFICANT RAINFALL AMOUNTS WHICH OCCURRED DURING A PERIOD OF HIGH RIVER STAGES
(Sections 2 And 3 Combined)

Date:	Jun 13 1953	Jul 3 1957	Apr 13 1960	May 7-8 1965	Apr 6 1967	Jun 14 1972	Apr 27 1975	Aug 29 1979	Mar 6 1983	May 12-13 1983	Jul 4 1983	May 6-8 1984	Jul 10-11 1984	Apr 15 1986	Apr 27-29 1986
Minn. River Discharge-cfs.:	22900	21700	18600	16100	18000	16800	16800	23200	27600	21700	17300	26100	17100	32100	26600
Stage:	708.34	707.97	706.96	706.04	706.73	706.29	706.29	708.44	709.73	707.97	706.46	709.33	706.39	711.03	709.50
Time (Hours)															
0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.5	1	3	1	1	2	1	1	1	2	1	3	1	2	2	4
1.0	5	11	2	6	4	5	1	7	7	2	14	4	7	8	10
1.5	11	23	3	15	6	10	1	13	13	4	28	10	15	16	17
2.0	15	32	4	31	9	18	2	17	16	4	35	16	18	18	19
2.5	16	35	6	49	13	25	4	18	16	5	32	19	18	15	16
3.0	14	33	7	58	17	25	6	22	13	8	23	16	14	10	11
3.5	10	29	8	56	21	19	8	27	11	11	15	12	11	6	6
4.0	6	23	8	47	22	12	11	27	9	12	9	8	11	3	4
4.5	4	17	9	37	20	7	12	21	6	12	6	6	17	2	2
5.0	2	11	11	28	16	4	11	13	4	10	3	4	31	1	1
5.5	1	7	12	22	11	3	9	8	3	7	2	3	46	1	1
6.0	1	4	11	17	7	2	7	5	2	5	1	3	52	0	0
6.5	0	2	9	12	4	1	6	3	2	3	1	3	48		
7.0		2	6	9	3	1	4	2	2	2	0	3	37		
7.5		1	4	6	2	0	3	1	1	1		3	24		
8.0		1	3	5	1		3	1	1	1		3	15		
8.5		0	3	4	1		5	0	1	0		2	9		
9.0			3	3	0		11		1			2	6		
9.5			4	3			17		1			2	3		
10.0			4	3			19		1			2	2		
10.5			4	2			18		0			2	1		
11.0			3	1			14					2	1		
11.5			2	1			10					2	0		
12.0			1	0			7					2			
12.5			1				5					2			
13.0			0				4					1			
13.5							2					1			
14.0							1					0			
14.5							1								
15.0							1								
15.5							0								

TABLE A-18

INTERCEPTOR STORMSEWER DESIGN
PLAN D

STANDARD PROJECT STORM PLAN

Sewer Segment (4)	1A-2	2-3	3-4	4-5	5-6	6	7-6	7-8	8-9	9-10	10	11-10	12-11	13-12	14-13
Design (SPS) Discharge-Cfs.	57	93	127	172	212	240	-	42	59	90	254	99	52	25	(3) 0
Required Pipe Length-Feet	482	394	392	334	336	(2) 90	198	206	182	154	(2) 93	400	222	250	190
Required Pipe Diameter-Inches	42	54	60	66	72	72	30	30	36	48	66	48	36	24	18
Given Upstream Crown Level (1)	703.37	702.41	701.62	700.84	700.17	699.50	699.90	699.90	699.67	699.31	699.00	699.62	700.06	700.56	700.94
Upstream Invert Elevation	699.87	697.91	696.62	695.34	694.17	693.50	697.40	697.40	696.67	695.31	693.50	695.62	697.06	698.56	699.44
Standard Project Storm															
Discharge-Cfs.	57	93	127	172	212	240		42	59	90	254	99	52	25	0
Head-Feet	2.30	1.66	1.86	1.99	2.03	2.37		3.87	2.95	1.66	3.28	3.36	2.57	4.72	0
Hyd. Grad	710.90	708.60	706.94	705.08	703.09	*701.06		710.33	706.46	703.51	*701.85	705.21	707.78	712.50	0
1% - Event															
Discharge-Cfs.	37	61	84	115	142	162		29	43	60	161	71	37	21	0
Head-Feet	1.03	0.71	0.81	0.89	0.91	0.92		1.85	1.57	0.74	1.32	1.73	1.30	3.33	0
Hyd. Grad	703.11	702.08	701.37	700.56	699.67	*698.76		703.84	701.99	700.42	*699.68	701.41	702.71	706.04	0
10% - Event															
Discharge-Cfs.	22	36	50	68	84	96		18	27	38	115	45	23	13	0
Head-Feet	0.36	0.25	0.29	0.31	0.32	0.32		0.27	0.62	0.30	0.67	0.69	0.50	1.28	0
Hyd. Grad	*702.14	*700.55	*699.52	*698.61	697.22	*696.90		*700.09	*699.35	698.19	*697.89	*698.70	*699.40	700.68	0
20% - Event															
Discharge-Cfs.	20	31	42	57	70	80		15	22	31	94	37	19	11	0
Head-Feet	0.30	0.18	0.20	0.22	0.22	0.22		0.49	0.41	0.20	0.45	0.47	0.34	0.91	0
Hyd. Grad	*702.04	*700.42	*699.27	*698.35	697.20	*696.98		*699.68	*699.06	*697.88	*697.35	*698.39	*699.16	*700.40	0
BLOCKED GRAVITY DESIGN (**)															
Pumping Station Located at Oak Street															
Seepage Only															
Discharge-Cfs.	1.8	2.2	2.6	3.3	6.6	-	10.8	14.0	16.8	18.4	-	15.9	11.9	9.0	9.0
Head-Feet	0.01	0.01	0.01	0.01	0.01	0.00	0.25	0.43	0.24	0.07	-	0.09	0.13	0.61	2.10
Hyd. Grad.	703.54	703.53	703.52	703.51	703.50	703.49	703.49	703.24	702.81	702.57	702.50	702.59	702.72	703.33	705.43
Gravity															
Discharge-Cfs.	5.2	7.9	11.0	15.0	18.3	-	21.0	24.5	25.1	28.1	-	7.5	3.7	1.2	1.2
Head-Feet	0.02	0.01	0.01	0.02	0.02	0.00	0.94	1.32	0.53	0.16	-	0.02	0.01	0.01	0.04
Hyd. Grad.	705.53	705.51	705.50	705.49	705.47	705.45	705.45	704.51	703.19	702.66	702.50	702.52	702.53	702.54	702.58

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* Inlet control.
** See Table A-19.
(1) Assumes a pipe slope of 0.002. Outlets B and C are to be laid with an outlet invert elevation of 693.0.
(2) Distance from interceptor sewer to gatewell.
(3) This sewer segment is required to carry seepage runoff only.
(4) Sewer segments refer to the locations as shown on Drawing Sheet 16.

TABLE A-19

DESIGN DISCHARGE RATES

Distribution Of Runoff During Blocked Conditions - Seepage Only

Inlet No. (***)	Station	Contrib. Watershed Location	Street Location	Design Q: 1%	SPS	10%	20%	Seepage Levee Length	Seepage (FT./HD.)* Per Section	Accum. Seepage ((Ft./Hd.)	Accumulated Seepage (Gpm.)**	(Cfs.)	Average Rate In Pipe Location	Seepage Pipe Discharge Cfs.
1A	76+35	1,2A	Spruce	37	57	22	20	1655	31.59	31.59	700	1.6		
2	71+15	2b	Hickory	24	36	14	11	520	9.93	41.52	920	2.1	1-2	1.8
3	67+05	2c	Elm	23	34	14	11	400	7.64	49.16	1089	2.4	2-3	2.2
4	63+03	2d	Cedar	31	45	18	15	380	7.25	56.41	1250	2.8	3-4	2.6
								320	6.11	62.52	1385			
5	59+51	2e	Pine	27	40	16	13	50	15.62	78.14	1732	3.9	4-5	3.3
6	55+88	2f	Chestnut	20	28	12	10	350	109.38	187.52	4155	9.3	5-6	6.6
7	53+94	3a		29	42	18	15	220	63.96	251.48	5573	12.4	6-7	10.8
8	51+85	3b	Walnut	14	17	9	7	220	63.96	315.44	6990	15.6	7-8	14.0
9	49+94	3c		17	31	11	9	170	49.42	364.86	8085	18.0	8-9	16.8
								240	69.76	434.62	9631	21.5		
10	47+95	3d	Oak	51	65	32	26	390	113.37	812.52	18005	40.1	9-10	18.4
11	43+75	3e	Ash	34	47	22	18	160	46.51	264.52	5862	13.1	11-10	15.9
12	41+43	3f		16	27	10	8	240	69.76	218.01	4831	10.8	12-11	11.9
13	38+36	3g	Maple	21	25	13	11	510	148.25	148.25	3285	7.3	13-12	9.0
14	36+38													

(*) Estimated seepage based on a 16-foot head is as follows:
Station 33+50 to Station 55+00 - 10,000 Gpm.
Station 55+00 to Station 59+00 - 2,000 Gpm.
Station 59+00 to Station 91+75 - 1,000 Gpm.
(**) Based on a 22.16 foot head.
(***) As shown on Drawing Sheet 16.

Distribution Of Runoff During Blocked Conditionsions - Gravity Flow

Inlet No. (***)	Station	Contrib. Watershed Location	Street Location	Peak Unit Q Cfs	%	Acc. %	Accum. Gpm	Runoff Cfs
1A	76+35	1,2A	Spruce	25	13.0	13.0	2332	5.2
2	71+15	2b	Hickory	13	6.7	19.7	3544	7.9
3	67+05	2c	Elm	15	7.8	27.5	4943	11.0
4	63+03	2d	Cedar	19	9.8	37.3	6715	15.0
5	59+51	2e	Pine	16	8.3	45.6	8207	18.3
6	55+88	2f	Chestnut	13	6.7	52.3	9420	21.0
7	53+94	3a		17	8.8	61.1	11005	24.5
8	51+85	3b	Walnut	3	1.6	62.7	11285	25.1
9	49+94	3c		14	7.3	69.9	12591	28.1
10	47+95	3d	Oak	22	11.4	100.0	18000	40.1
11	43+75	3e	Ash	18	9.3	18.7	3366	7.5
12	41+43	3f		12	6.2	9.3	1674	3.7
13	38+36	3g	Maple	6	3.1	3.1	558	1.2
14	36+38							
			Total	193	100.0			

TABLE A-20

REQUIRED SIZE OF GRATED INLETS AND CONNECTING FEEDER PIPE

Inlet No. (10)	Contrib. Wat'shed Location	Design Q 1%	Design Q SPS	Approx. Rim Elev.	Max. Allow. Pond Level (SPS)	Max. Allow. Head (Ft.) (1)	Reqd. Perm. (Ft.) (3)	Reqd. Area (A) (SqFt.) (4)	Recommended Area 2A (SqFt.) (5)	Available Head In Feet (7)	One Inlet: Required RCP Pipe Size (Inches) (8)	One Inlet: HW	One Inlet: Max. Allow. Inlet Invert Elev. (9)	Two Inlets: Required RCP Pipe Size (Inches) (8)	Two Inlets: HW	Two Inlets: Max. Allow. Inlet Invert Elev. (9)
	REQUIRED SIZE OF GRATES						Based On A Single Inlet (6)			**REQUIRED SIZE AND LEVEL OF FEEDER PIPES**	Based on One Inlet			Based on Two Inlets		
1A	2a	37	57	710	710.9	0.9	22.3	12.5	25.0	0.11	-	-	-	48	2.4	708.5
2	2b	24	36	710	710.9	0.9	14.1	7.9	15.8	2.70	30	3.9	707.0	24	2.7	708.2
3	2c	23	34	710	710.9	0.9	13.3	7.4	14.9	4.38	24	6.0	704.9	24	2.6	708.3
4	2d	31	45	710	710.9	0.9	17.6	9.9	19.7	6.21	24	9.4	701.5	24	3.4	707.5
5	2e	27	40	710	710.9	0.9	15.6	8.8	17.5	8.31	24	7.6	703.3	24	3.0	707.9
6	2f	20	28	714	710.9	(2) 1.0	9.3	5.8	11.6	10.38	24	3.5	707.4	24	2.2	708.7
7	3a	29	42	711	712.5	1.5	7.6	7.1	14.2	1.72	36	3.5	709.0	24	3.2	709.3
8	3b	14	17	710	712.5	2.5	1.4	2.2	4.5	5.76	24	2.6	709.9	-	-	-
9	3c	17	31	709	712.5	3.5	1.6	3.4	6.9	8.60	24	5.3	707.2	24	2.3	710.2
10	3d	51	65	708	712.5	4.5	2.3	6.4	12.7	10.65	36	5.6	706.9	24	5.6	706.9
11	3e	34	47	708	712.5	4.5	1.6	4.6	9.2	7.34	24	9.8	702.7	24	3.6	708.9
12	3f	16	27	708	712.5	4.5	0.9	2.6	5.3	5.20	24	4.3	708.2	-	-	-
13	3g	21	25	709	712.5	3.5	1.3	2.8	5.6	0.62	36	2.4	710.1	24	2.0	710.2

(1) Allowable pond level, less rim elevation.
(2) Ground level in area will permit this condition.
(3) $Q = 3*L*H^{1.5}$, $L = Q/(3*H^{1.5})$
(4) $Q = 0.6*A*(2*G*H)^{0.5}$, $A = Q/((0.6*(2*G*H)^{0.5})$
(5) Assumes grate is 50 percent obstructed.
(6) With two inlets, the indicated requirements can be reduced 50 percent.
(7) Maximum allowable pond level (SPS), less resulting hyd gradiant for SPS from Table A-18.
(8) Assumes a pipe length of 20 feet.
(9) Maximum allowable pond level, less HW.
(10) As shown on Drawing Sheet 16.

TABLE A-21

ONE PERCENT AND SPS POND LEVELS

Location:	Section 2		Section 3	
Event:	1%	SPS	1%	SPS
Existing Conditions:				
Maximum Interior Pond Level	709.9	710.9	711.0	712.5
Estimated Damages In $1000	0.0	0.0	255.0	420.0
Proposed Conditions:				
Maximum Interior Pond Level	703.2	710.9	706.0	711.5
Estimated Damages In $1000	0.0	0.0	0.0	420.0

TABLE A-22

ESTIMATED SEEPAGE DURING A STANDARD PROJECT FLOOD

Day	Flow In CFS At Mankato	At Chaska	Minn. River Elev.	Head In Feet Above 706.0	Estimated Seepage (Gpm)
0	6000	6503	699.89		
1	7500	8129	701.52		
2	13000	14090	705.24		
3	22000	23845	708.63	2.63	2138
4	37500	40645	712.93	6.93	5634
5	57000	61781	717.26	11.26	9154
6	85000	92129	722.25	16.25	13211
7	105000	113806	725.30	19.30	15691
8	123000	133316	727.11	21.11	17162
9	136500	147948	728.26	22.26	18097
10	149500	162039	729.20	23.20	18862
11	155000	168000	729.58	23.58	19171
12	150500	163123	729.27	23.27	18919
13	142500	154452	728.70	22.70	18455
14	132500	143613	727.97	21.97	17862
15	121000	131148	726.93	20.93	17016
16	107500	116516	725.61	19.61	15943
17	91000	98632	723.23	17.23	14008
18	75000	81290	720.60	14.60	11870
19	63000	68284	718.38	12.38	10065
20	52500	56903	716.37	10.37	8431
21	44000	47690	714.54	8.54	6943
22	37500	40645	712.93	6.93	5634
23	31500	34142	711.54	5.54	4504
24	27000	29265	710.19	4.19	3406
25	24000	26013	709.30	3.30	2683
26	21500	23303	708.47	2.47	2008
27	19500	21135	707.82	1.82	1480
28	17500	18968	707.10	1.10	894
29	16500	17884	706.69	0.69	561
30	14500	15716	705.89		
31	14000	15174	705.67		
32	13000	14090	705.24		
33	12500	13548	705.02		
34	11500	12465	704.42		
35	11000	11923	704.12		

TABLE A-23

PERIODS WHEN MINNESOTA RIVER EQUALLED OR EXCEEDED ELEVATION 706.0
October 1, 1934 Through September 30, 1987
(Q = 16,000 CFS.)

Year	Dates From	To	Number Of Days	Minnesota River Peak Q In CFS.	Peak Level	Precip. In Inches	Maximum Pond Levels No Pumping	5000 Gpm	10000 Gpm	15000 Gpm	18000	20000	25000	Peak Runoff Runoff (Cfs)	Seepage (Gpm)	Total (Gpm)
1936	Mar 24	Mar 29	6	23200	708.4	1.62	711.80	706.00	-	-						
1943	Jun 17	Jun 26	10	25900	709.3	0.03	710.07	706.00	-	-						
1944	May 4	Jun 12	40	25100	709.0	8.51	717.00	711.62	710.24	706.00						
	Jun 15	Jun 25	11	19100	707.1	1.19	711.40	710.01	706.00	-						
1945	Mar 18	Mar 22	5	17700	706.6	0.00	706.50	706.00	-	-						
	Jun 17	Jun 22	6	18000	706.7	0.51	710.72	706.00	-	-						
1947	Apr 19	May 10	22	20422	707.6	2.29	712.22	706.00	-	-						
	Jul 9	Jul 15	7	18300	706.9	0.86	711.09	706.00	-	-						
1948	Mar 23	Apr 3	12	21800	708.0	0.52	710.83	706.00	-	-						
1949	Mar 31	Apr 16	17	31600	710.9	1.03	711.51	710.17	706.00	-						
1951	Apr 9	May 11	33	62900	717.4	2.80	716.37	712.15	710.48	706.00						
	Jul 3	Jul 8	6	19800	707.4	0.48	710.68	706.00	-	-						
1952	Apr 3	May 7	35	59100	716.8	1.09	716.11	711.65	710.33	706.00						
1953	Jun 12	Jun 17	6	22900	708.3	0.92	711.21	710.24	706.00	-						
	Aug 8	Aug 9	2	16300	706.1	0.05	710.76	706.00	-	-						
	Aug 11	Aug 12	2	16100	706.0	0.51	710.69	706.00								
1957	Jun 25	Jul 6	12	40200	712.8	2.28	713.59	710.84	710.32	708.50	706.00	-	-	35	1620	17330
1960	Apr 4	Apr 21	18	24200	708.7	1.09	711.31	710.06	706.00	-						
	May 23	Jun 1	10	35100	711.8	0.84	711.91	711.38	706.00	-						
1962	Apr 2	Apr 28	27	39400	712.7	0.74	712.64	710.27	706.00	-						
	May 25	May 28	4	17100	706.4	0.56	710.77	706.00	-	-						
	Jul 13	Jul 15	3	16500	706.2	0.52	710.70	706.00	-	-						
1965	Apr 8	May 7	30	112000	725.1	4.55	718.42	717.20	714.66	711.13	709.70	709.20	708.10	58	30	26030
	May 9	May 15	7	17200	706.4	1.35	711.54	706.00								
	Jun 1	Jun 4	4	16600	706.2	1.40	711.58	706.00	-	-						
	Jun 12	Jun 13	2	16800	706.3	0.00	706.20	706.00	-	-						
1966	Apr 6		1	16000	706.0	0.00	706.00	-	-	-						
1967	Apr 7	Apr 12	8	19300	707.2	1.42	711.59	710.32	706.00	-						
	Jun 21	Jun 24	4	17500	706.5	1.04	711.45	706.00	-	-						
1968	Oct 20	Nov 2	14	37200	712.3	0.19	711.92	710.24	706.00	-						
1969	Mar 28	May 12	46	84500	721.1	2.61	717.16	714.63	711.55	706.00	-	-	-	4	12270	14060
1971	Mar 20	Apr 10	22	24100	708.7	0.15	710.30	706.00	-	-						
1972	Mar 21	Mar 24	4	16600	706.2	0.52	710.71	706.00	-	-						
	Jun 13	Jun 16	4	16800	706.3	1.17	711.38	710.33	710.04	706.00	-	-	-	25	0	11220
1973	Mar 15	Mar 25	11	21500	707.9	0.62	710.85	706.00	-	-						
1975	Apr 26	May 9	14	22900	708.3	2.68	712.67	710.17	706.00	-						
1979	Apr 1	May 7	37	32000	711.0	1.67	712.24	710.23	706.00	-						
	May 16	May 19	4	16600	706.2	0.27	710.38	706.00	-	-						
	Aug 25	Sep 7	14	27200	709.6	1.97	712.00	710.87	710.26	706.00				27	2650	14770
1982	Mar 23	Mar 29	7	17200	706.4	0.01	710.01	706.00	-	-						
1983	Mar 2	Mar 25	24	30000	710.5	2.14	712.12	710.51	710.27	706.00		-	-	16	3610	10790
	Apr 4	May 3	30	33300	711.3	3.13	712.79	710.17	706.00	-						
	May 8	May 21	14	22100	708.1	1.35	711.54	706.00	-	-						
	Jul 4	Jul 14	11	25500	709.1	1.43	711.61	710.60	710.22	708.10	706.00	-	-	35	410	16110
1984	Mar 29	May 20	53	33500	711.4	4.94	714.60	710.48	710.05	706.00		-	-	19	3360	11890
	Jun 16	Jul 12	27	44800	714.0	4.16	715.34	711.38	710.81	709.70	709.10	708.70	706.00	52	240	23580
1985	Mar 16	Apr 11	27	31900	711.0	1.74	712.24	710.21	706.00	-						
	Apr 25	May 7	13	20200	707.6	0.11	710.16	706.00	-	-						
1986	Mar 22	May 28	68	36600	712.2	7.59	716.14	710.61	710.13	706.00		-	-	18	5260	13340
	Jun 23	Jul 3	11	26300	709.4	0.79	711.05	706.00	-	-						
	Sep 24	Oct 7	14	24400	708.8	0.54	710.75	706.00	-	-						
TOTALS			819			77.98										

TABLE A-24

CONVERSION OF POND LEVELS INTO DAMAGES
GATE CLOSURE AT ELEVATION 706.0
PERIOD OF RECORD ANALYSIS

Elev.	Damages ($1000) Section 2	Section 3	Total	Frequency of Events in 100 Years, Station Capacity in Gpm: 0	5000	10000	15000	20000
710.5		0	0	46.00	20.00	8.70	3.60	0.30
711.0	0	255	255	40.50	13.50	5.00	2.00	
711.5	140	300	440	35.00	9.80	4.00	1.10	
712.0	175	360	535	28.00	6.90	3.30	0.28	
712.5	210	420	630	21.00	5.80	2.90	0.025	
713.0	255	490	745	16.60	5.00	2.60		
713.5	300	565	865	15.20	4.40	2.30		
714.0	350	650	1000	14.60	4.10	2.10		
714.5	410	740	1150	14.30	3.90	1.90		
715.0	465	835	1300	13.80	3.30	1.60		
715.5	530	935	1465	12.00	3.00	1.05		
716.0	600	1040	1640	9.90	2.70	0.55		
716.5	675	1150	1825	7.60	2.30	0.23		
717.0	750	1270	2020	5.70	1.90	0.06		
717.5	835	1370	2205	4.00	1.45	0.013		
718.0	920	1485	2405	2.60	0.95			
718.5	1035	1575	2610	1.80	0.55			
719.0	1145	1660	2805	1.05	0.28			
719.5	1260	1730	2990	0.63	0.10			
720.0	1370	1800	3170	0.36	0.028			

TABLE A-25

DETERMINATION OF AVERAGE ANNUAL PUMPING COSTS

Design Pump Capacity (Gpm)	Estimated Total Cost	First Costs ($1000) Pumps Only (1)	Structure Only	Present Worth Pumps (2)	Energy & Maintenance (3)	Total	Estimated Average Annual Cost (4)
2000	50	22.5	27.5	23.9	7.9	59.3	5.27
5000	250	112.5	137.5	119.7	7.9	265.1	23.53
10000	350	157.5	192.5	167.6	7.9	368.0	32.66
15000	450	202.5	247.5	215.4	7.9	470.8	41.80
20000	550	247.5	302.5	263.3	7.9	573.7	50.93

(1) Pump cost assumed to be about 45% of total cost.

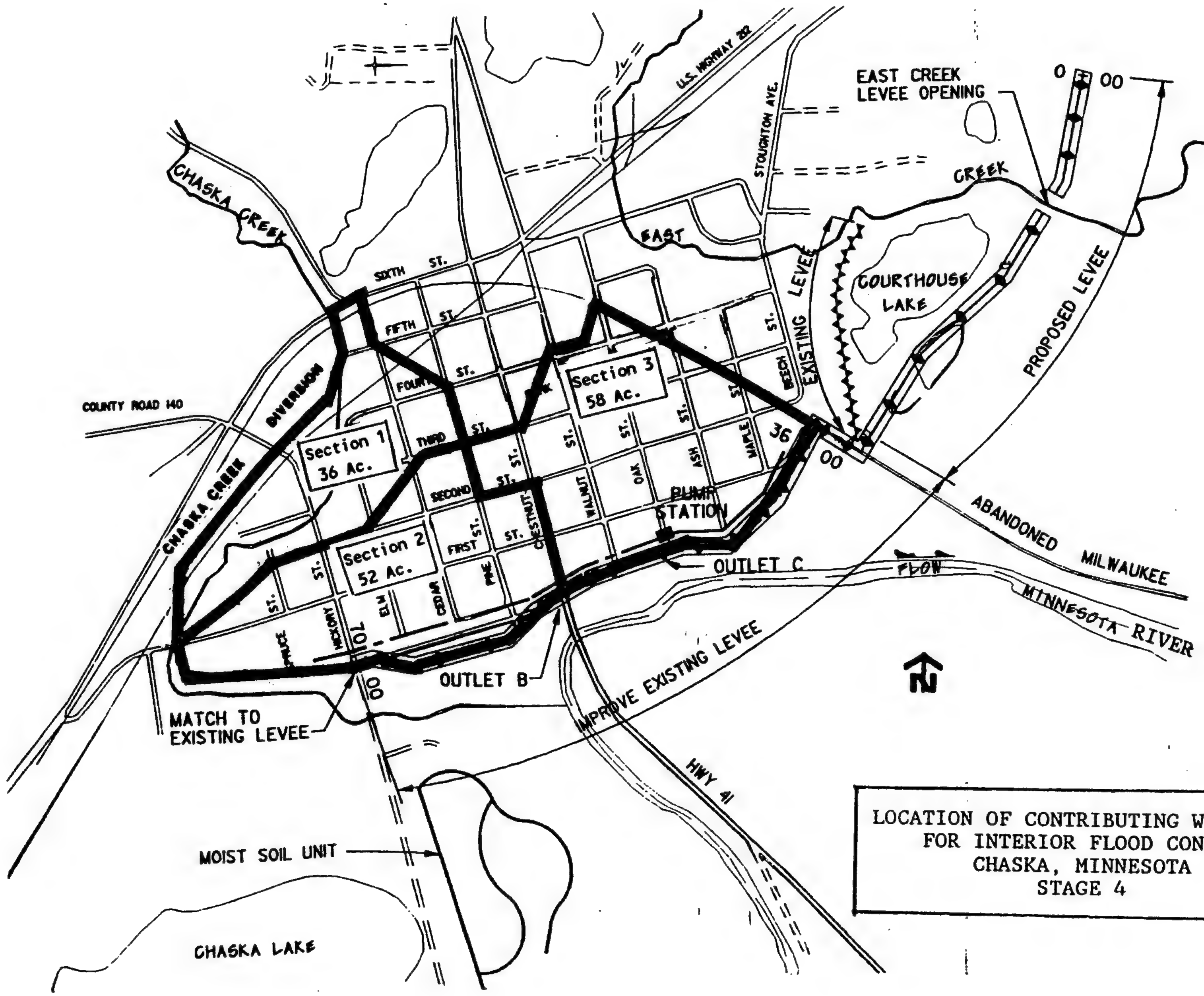
(2) Assuming pumps are replaced every 33 years with a 8.875% interest rate (1.0639).

(3) Estimated present worth of maintenance and energy costs:
(Obtained from pages E-6 and E-7 of St. Paul DM, dated March 1990.)

Energy Costs	$ 13949	
Maintenance Costs	9818	

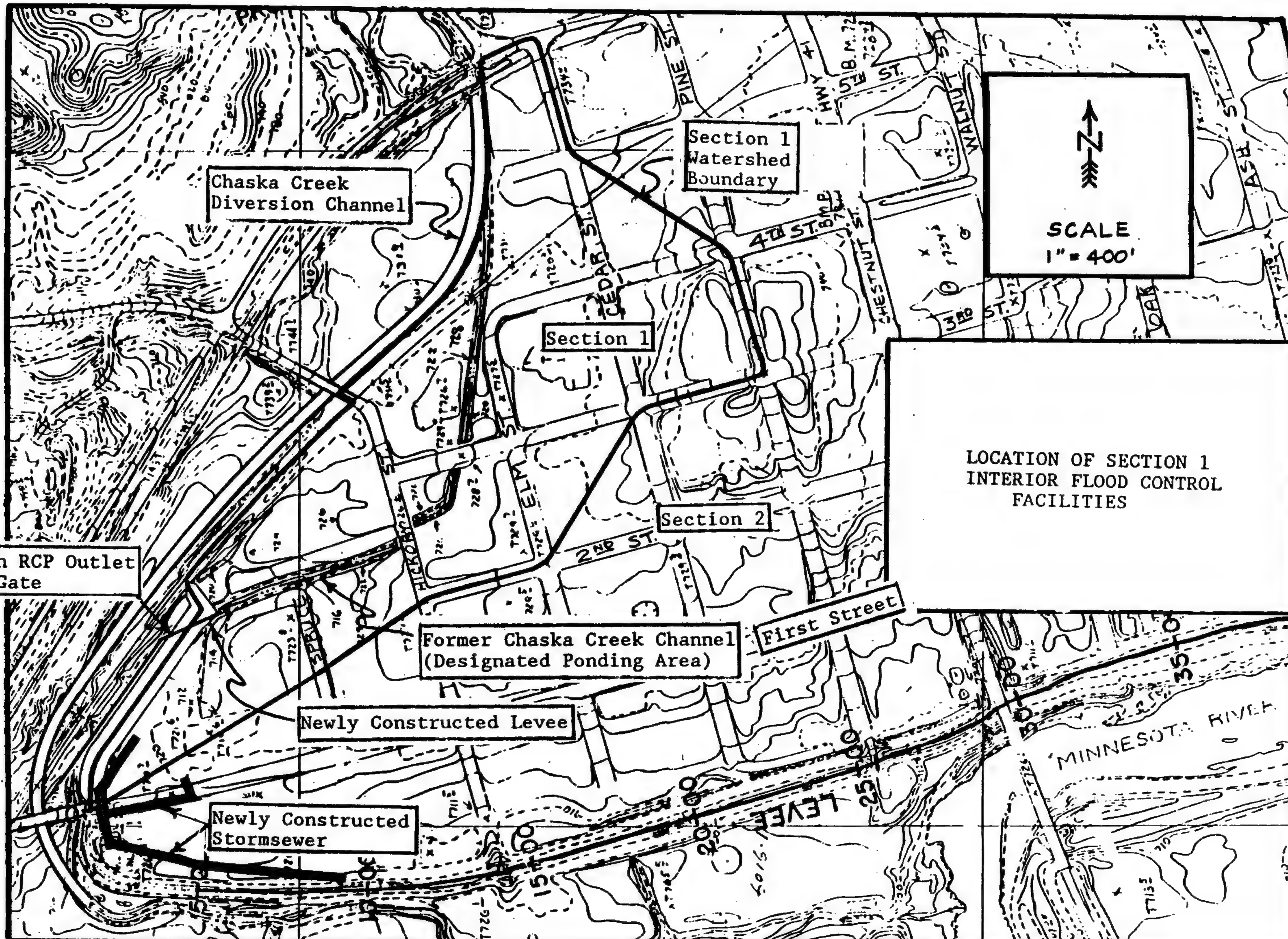
Total	$ 23767 / 3 =	$ 7922

(4) Average amannual cost / present worth factor for a 100 year life is 0.08877.



LOCATION OF CONTRIBUTING WATERSHEDS
FOR INTERIOR FLOOD CONTROL
CHASKA, MINNESOTA
STAGE 4

PLATE A-1



LOCATION OF SECTION 1
INTERIOR FLOOD CONTROL
FACILITIES
SCALE
1" = 400'
N
Chaska Creek
Diversion Channel
Section 1
Watershed
Boundary
Section 1
Section 2
New 60-Inch RCP Outlet
With Flap Gate
Former Chaska Creek Channel
(Designated Ponding Area)
First Street
Newly Constructed Levee
Newly Constructed
Stormsewer
PINE ST.
CEDAR ST.
4TH ST.
CHESTNUT ST.
WALNUT ST.
5TH ST.
HWY 41
3RD ST.
OAK
ASH ST.
ELM
2ND ST.
HICKORY
SPRUCE
LEVEE
MINNESOTA RIVER

PLATE A-2

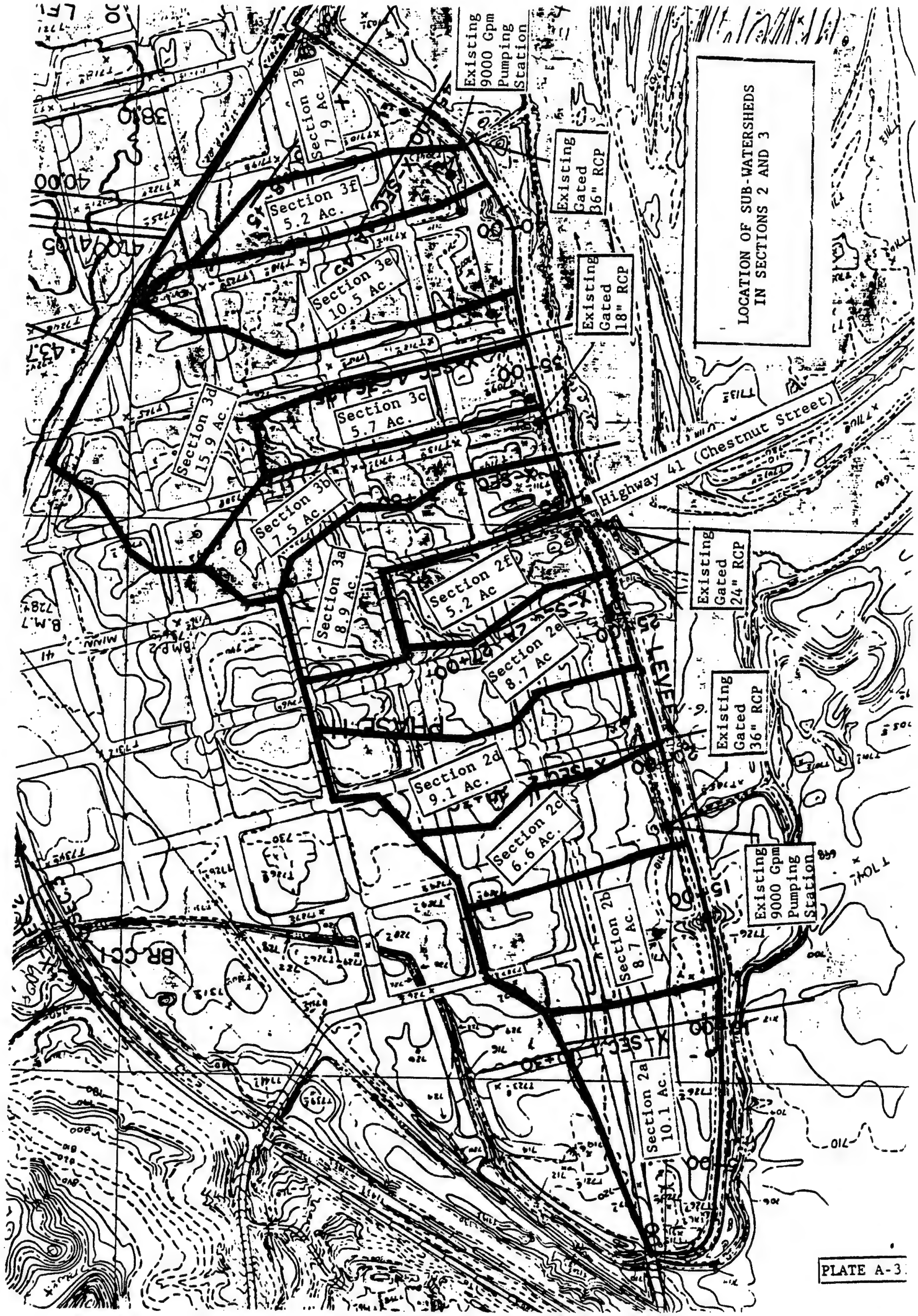
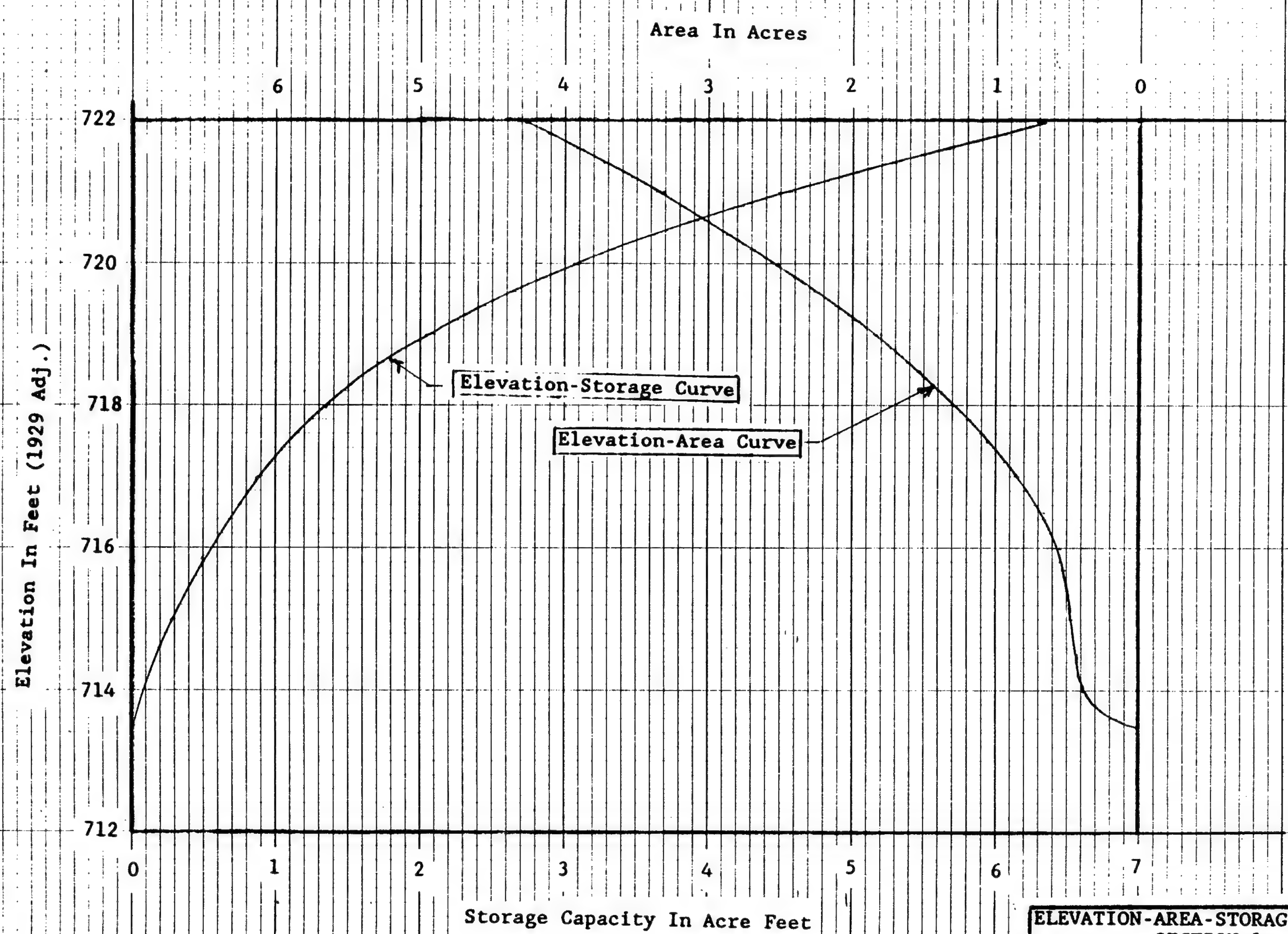
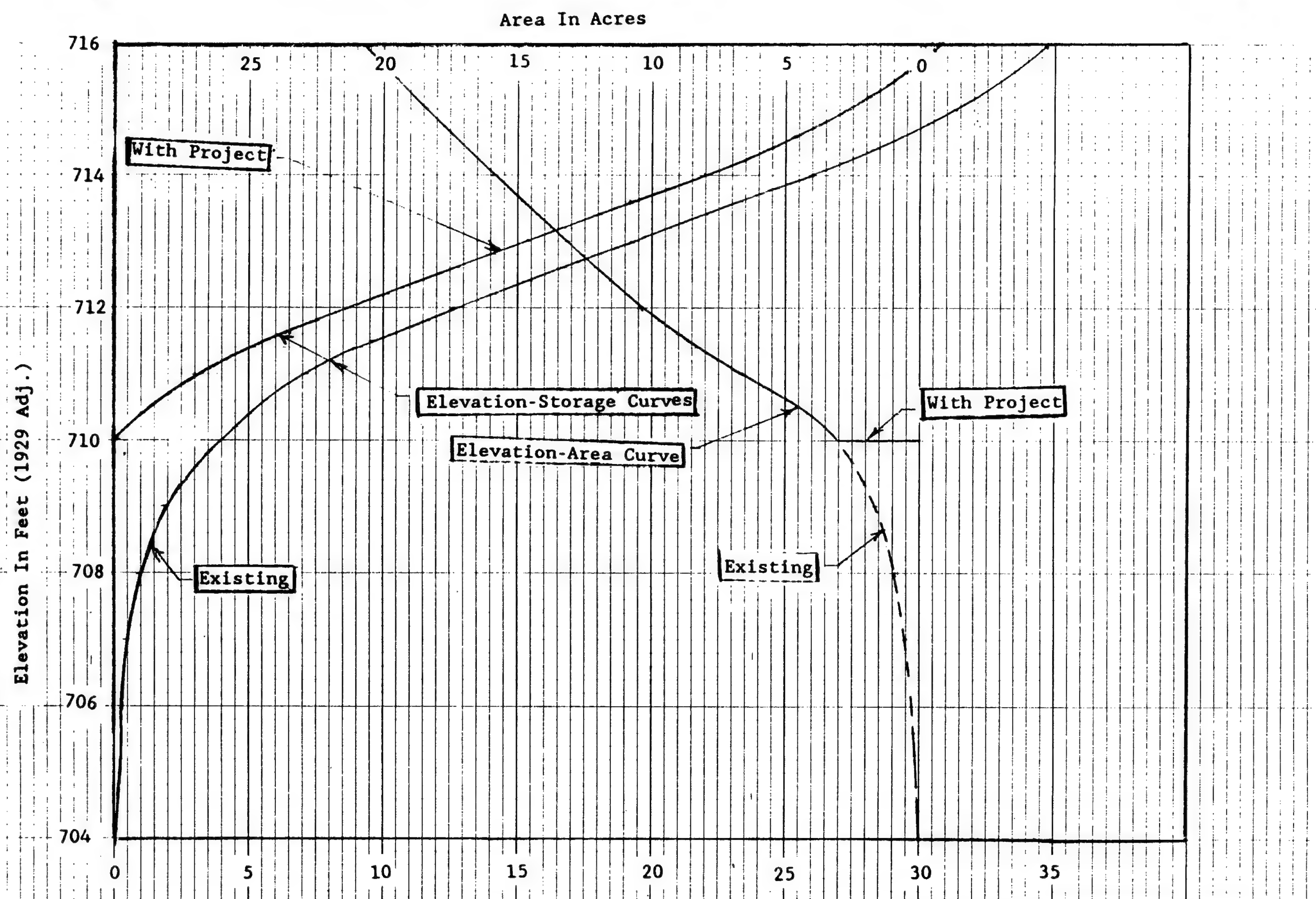

LOCATION OF SUB-WATERSHEDS
IN SECTIONS 2 AND 3
Existing 9000 Gpm Pumping Station
Existing Gated 36" RCP
Existing Gated 18" RCP
Highway 41 (Chestnut Street)
Existing Gated 24" RCP
Existing Gated 36" RCP
Existing 9000 Gpm Pumping Station
Section 3g 7.9 Ac.
Section 3f 5.2 Ac.
Section 3e 10.5 Ac.
Section 3d 15.9 Ac.
Section 3c 5.7 Ac.
Section 3b 7.5 Ac.
Section 3a 8.9 Ac.
Section 2f 5.2 Ac.
Section 2e 8.7 Ac.
Section 2d 9.1 Ac.
Section 2c 6.6 Ac.
Section 2b 8.7 Ac.
Section 2a 10.1 Ac.
LEVEE

PLATE A-3

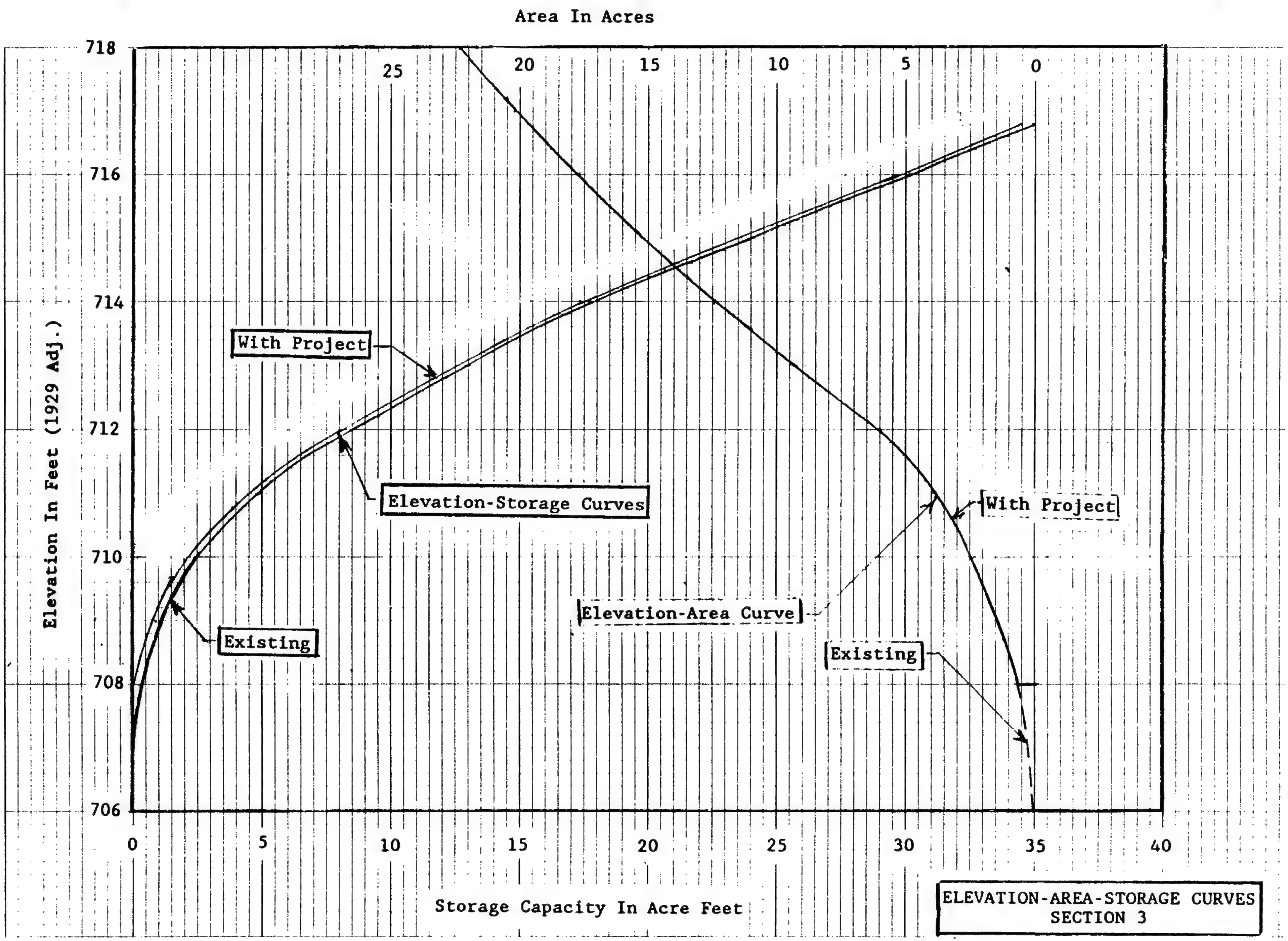


ELEVATION-AREA-STORAGE CURVES
SECTION 1

PLATE A-4



ELEVATION-AREA-STORAGE CURVES
SECTION 2



ELEVATION-AREA-STORAGE CURVES
SECTION 3

PLATE A-6

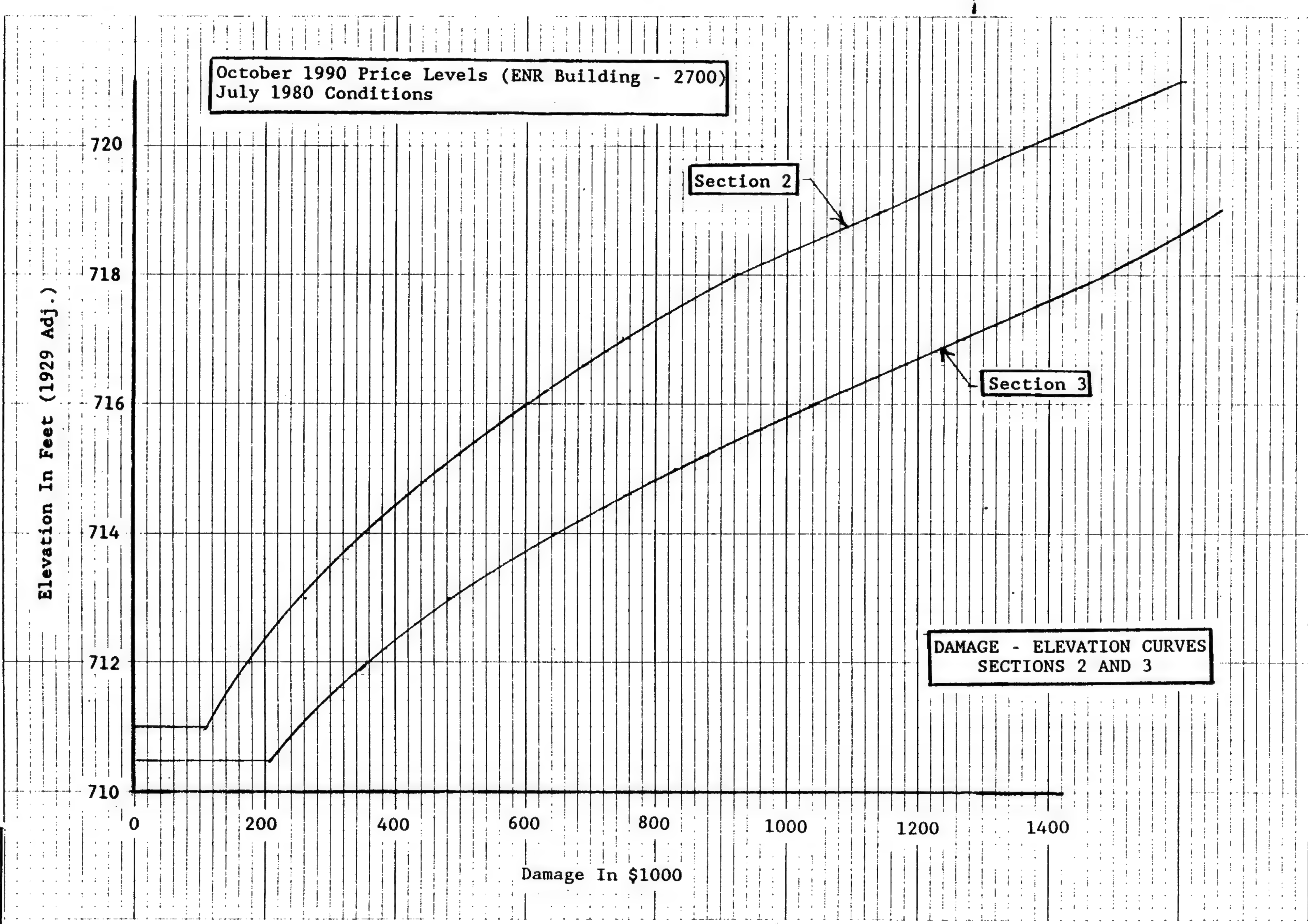
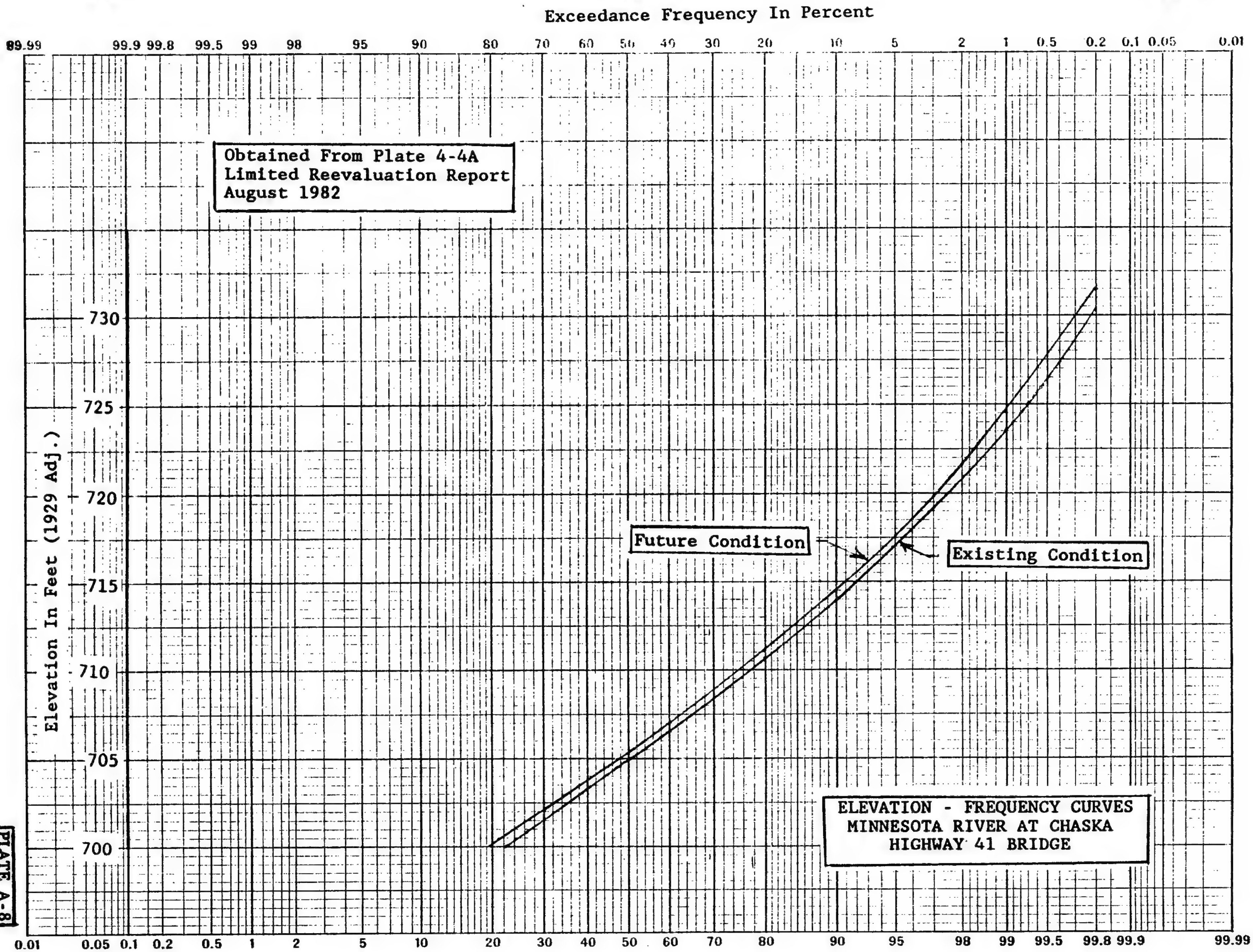

October 1990 Price Levels (ENR Building - 2700)
July 1980 Conditions
Section 2
Section 3
DAMAGE - ELEVATION CURVES
SECTIONS 2 AND 3
Elevation In Feet (1929 Adj.)
710
712
714
716
718
720
0
200
400
600
800
1000
1200
1400
Damage In $1000

PLATE A-7


Exceedance Frequency In Percent
Elevation In Feet (1929 Adj.)
700
705
710
715
720
725
730
Obtained From Plate 4-4A
Limited Reevaluation Report
August 1982
Future Condition
Existing Condition
ELEVATION - FREQUENCY CURVES
MINNESOTA RIVER AT CHASKA
HIGHWAY 41 BRIDGE

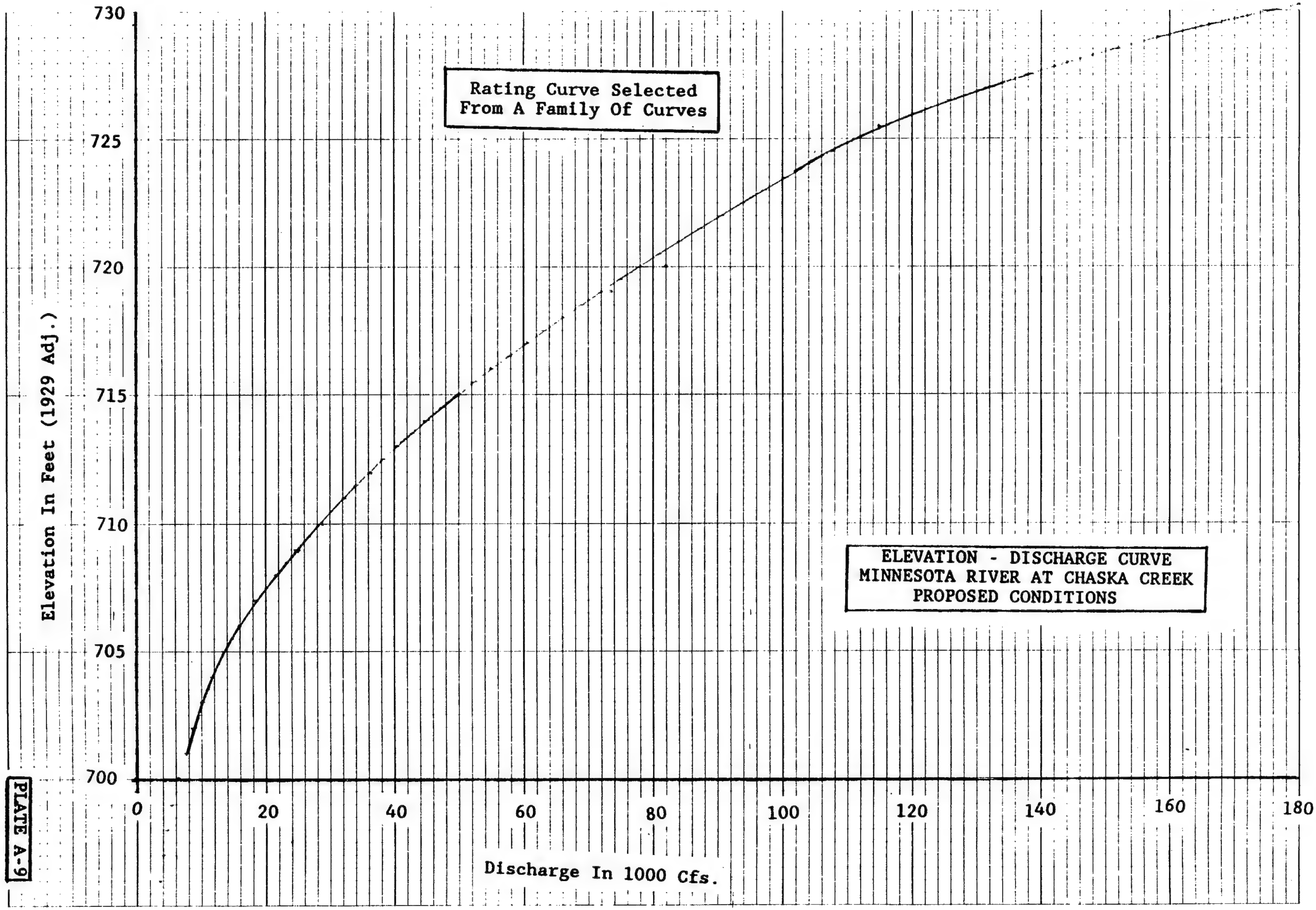
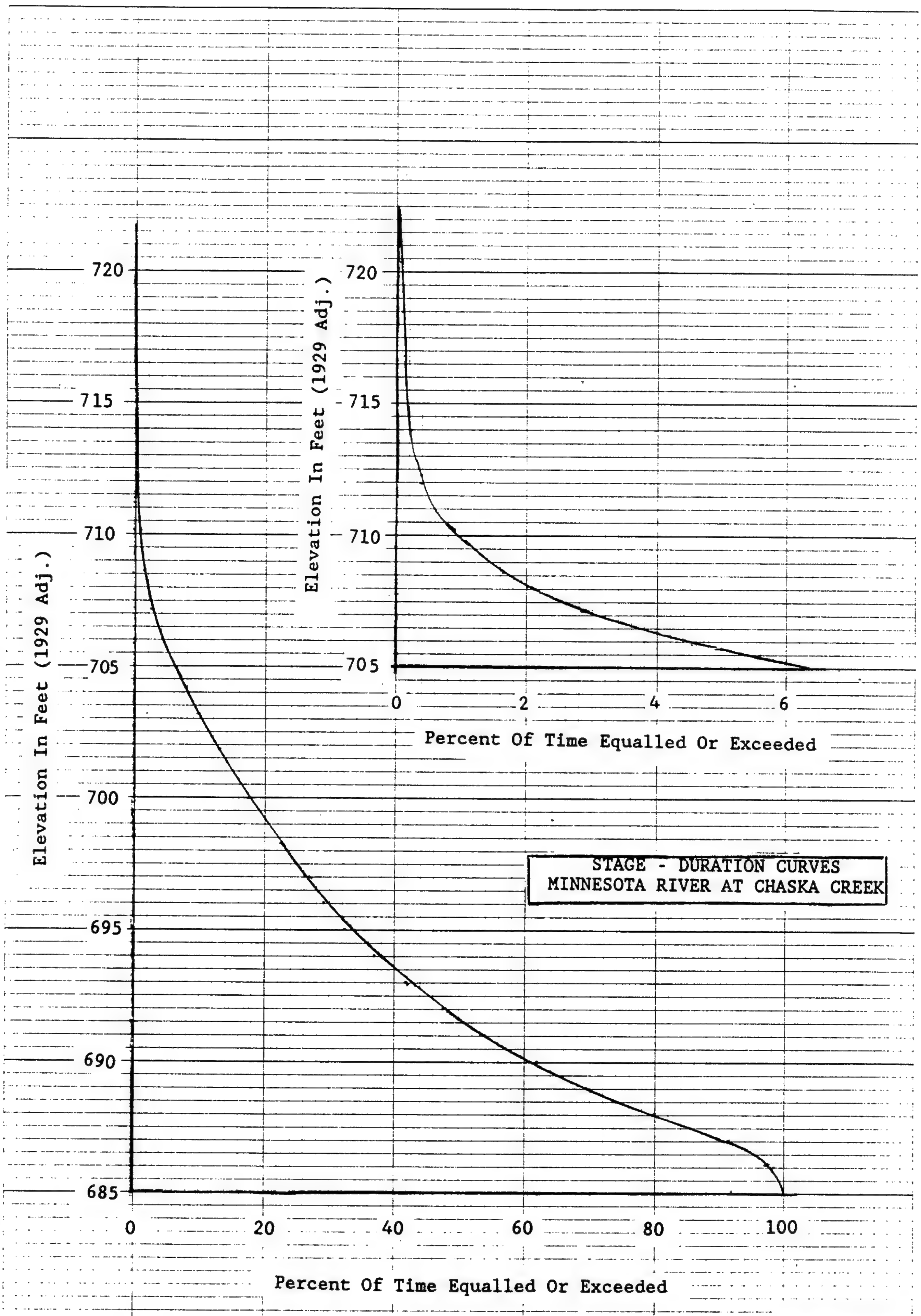
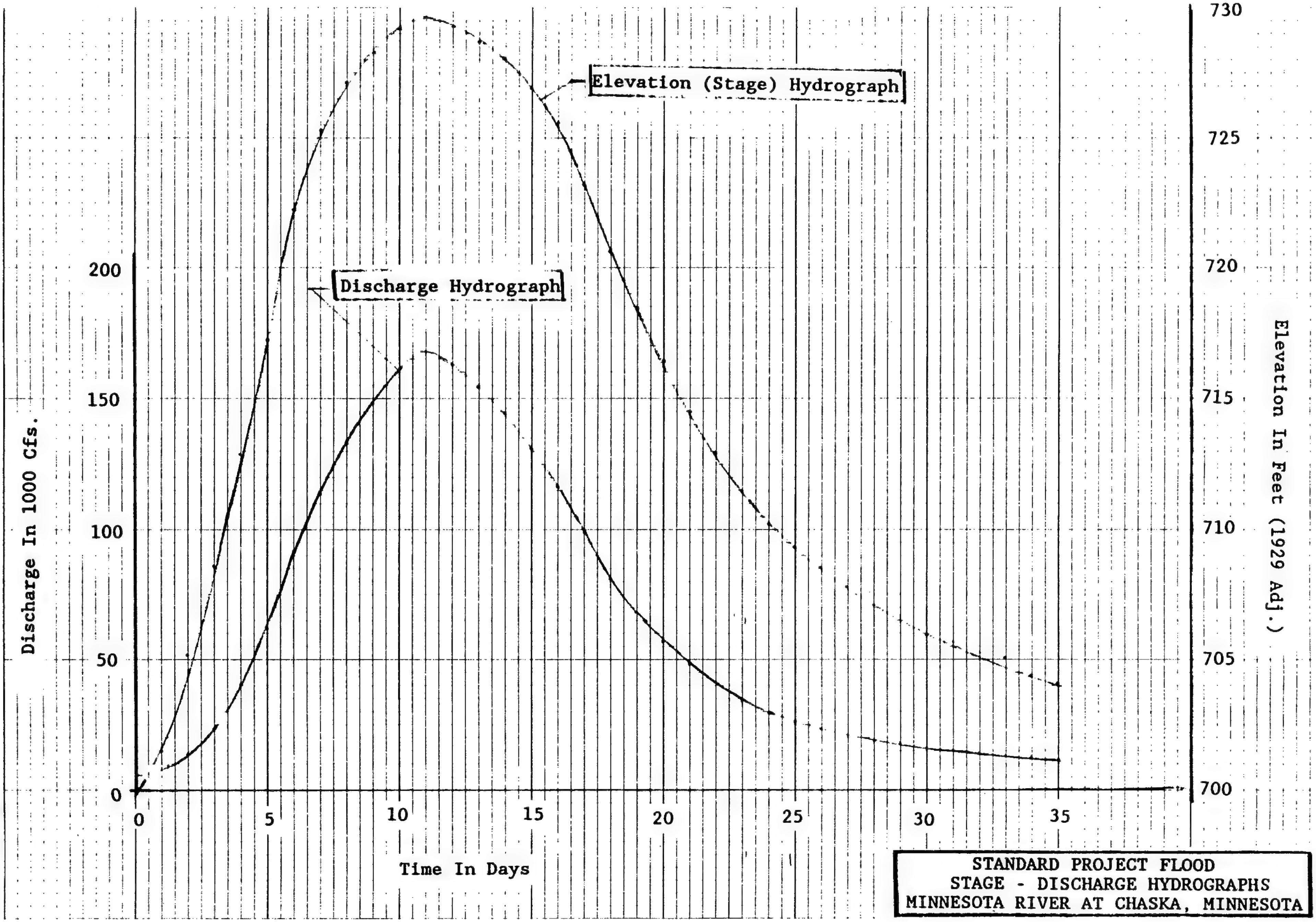

Rating Curve Selected
From A Family Of Curves
ELEVATION - DISCHARGE CURVE
MINNESOTA RIVER AT CHASKA CREEK
PROPOSED CONDITIONS
Elevation In Feet (1929 Adj.)
Discharge In 1000 Cfs.
730
725
720
715
710
705
700
0
20
40
60
80
100
120
140
160
180

PLATE A-9



46 0700

10 X 10 TO THE INCH • 7 x 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.



STANDARD PROJECT FLOOD
STAGE - DISCHARGE HYDROGRAPHS
MINNESOTA RIVER AT CHASKA, MINNESOTA

PLATE A-11

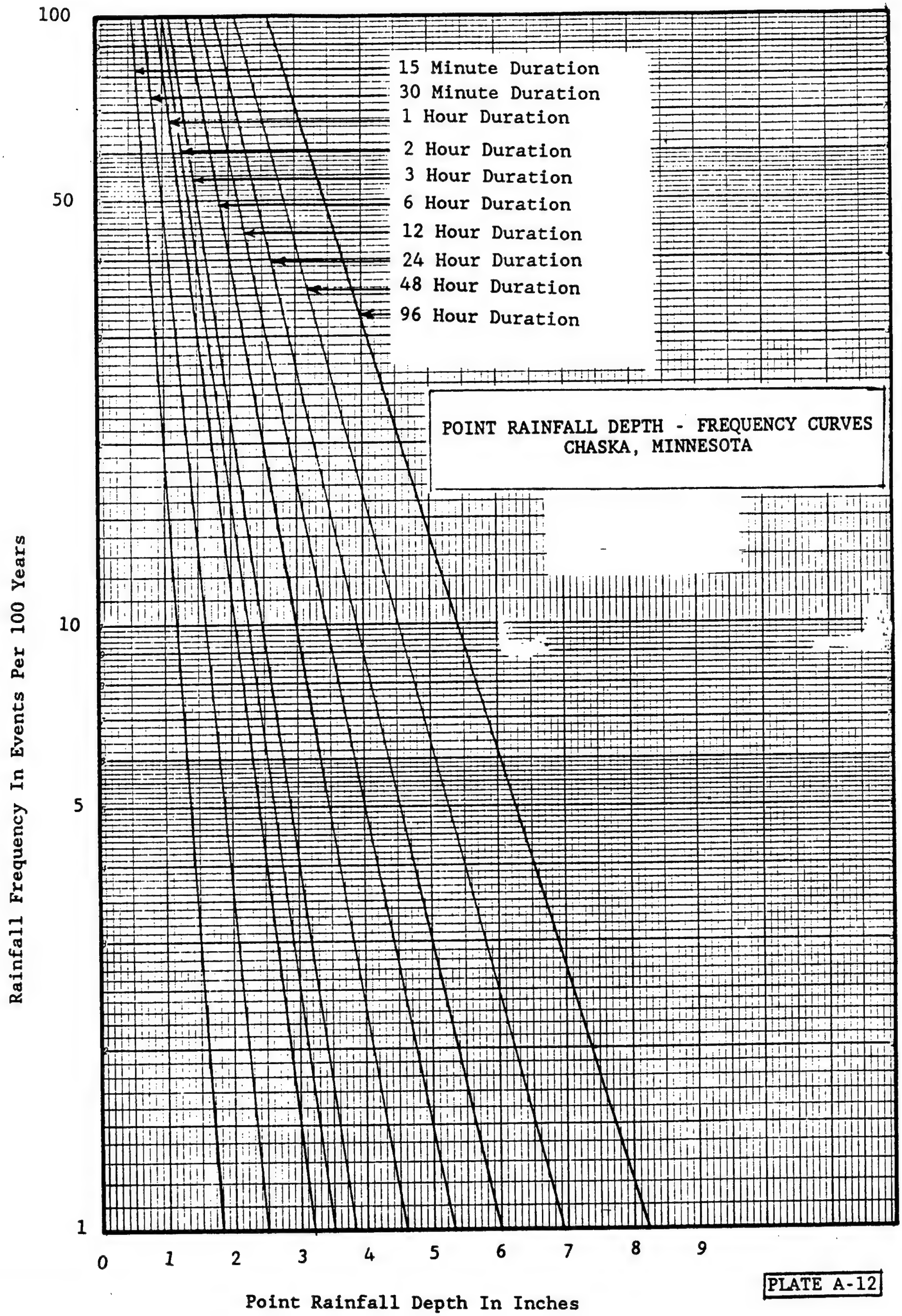
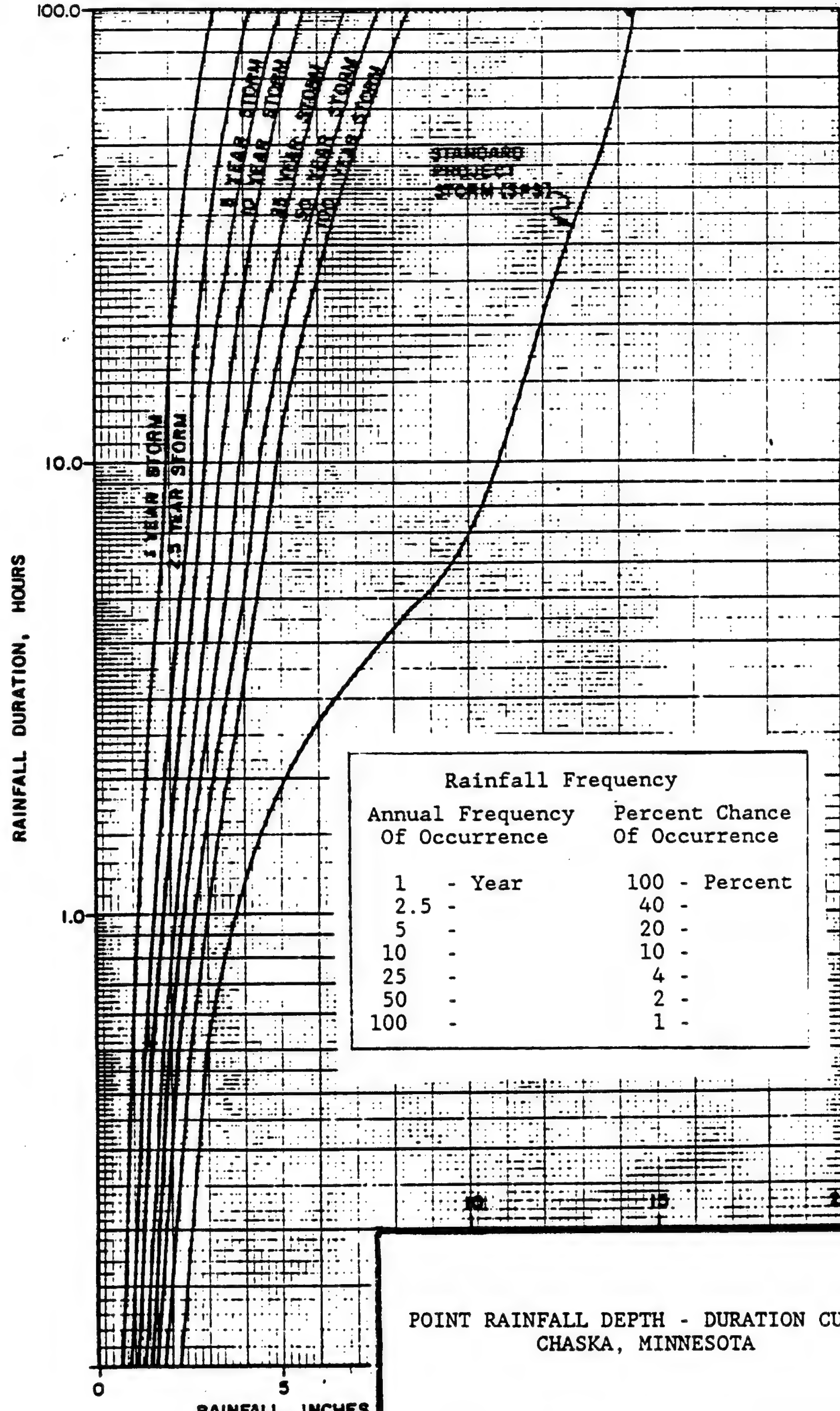

100
50
10
5
1
15 Minute Duration
30 Minute Duration
1 Hour Duration
2 Hour Duration
3 Hour Duration
6 Hour Duration
12 Hour Duration
24 Hour Duration
48 Hour Duration
96 Hour Duration
POINT RAINFALL DEPTH - FREQUENCY CURVES
CHASKA, MINNESOTA
Rainfall Frequency In Events Per 100 Years
0
1
2
3
4
5
6
7
8
9
Point Rainfall Depth In Inches

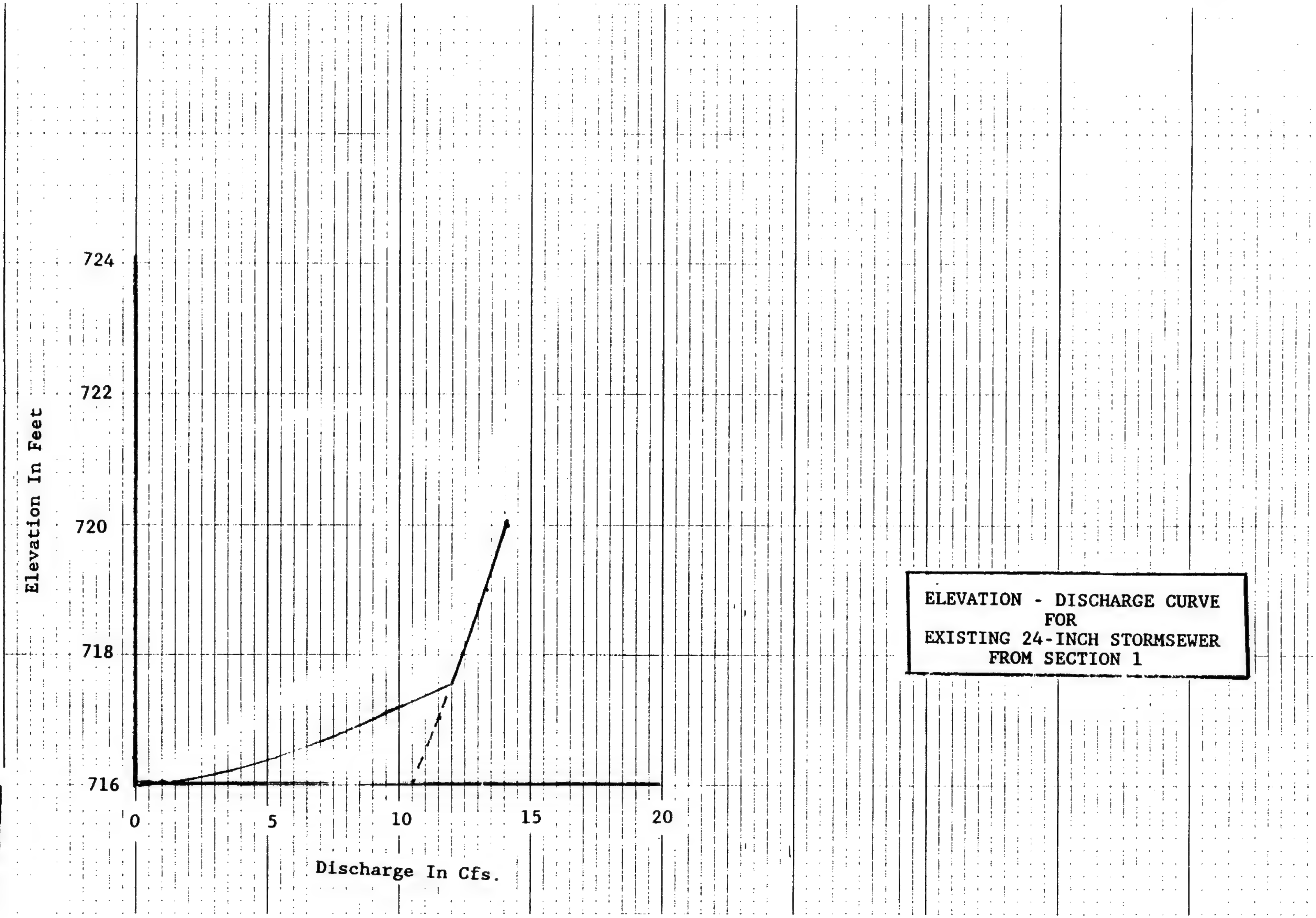
PLATE A-12

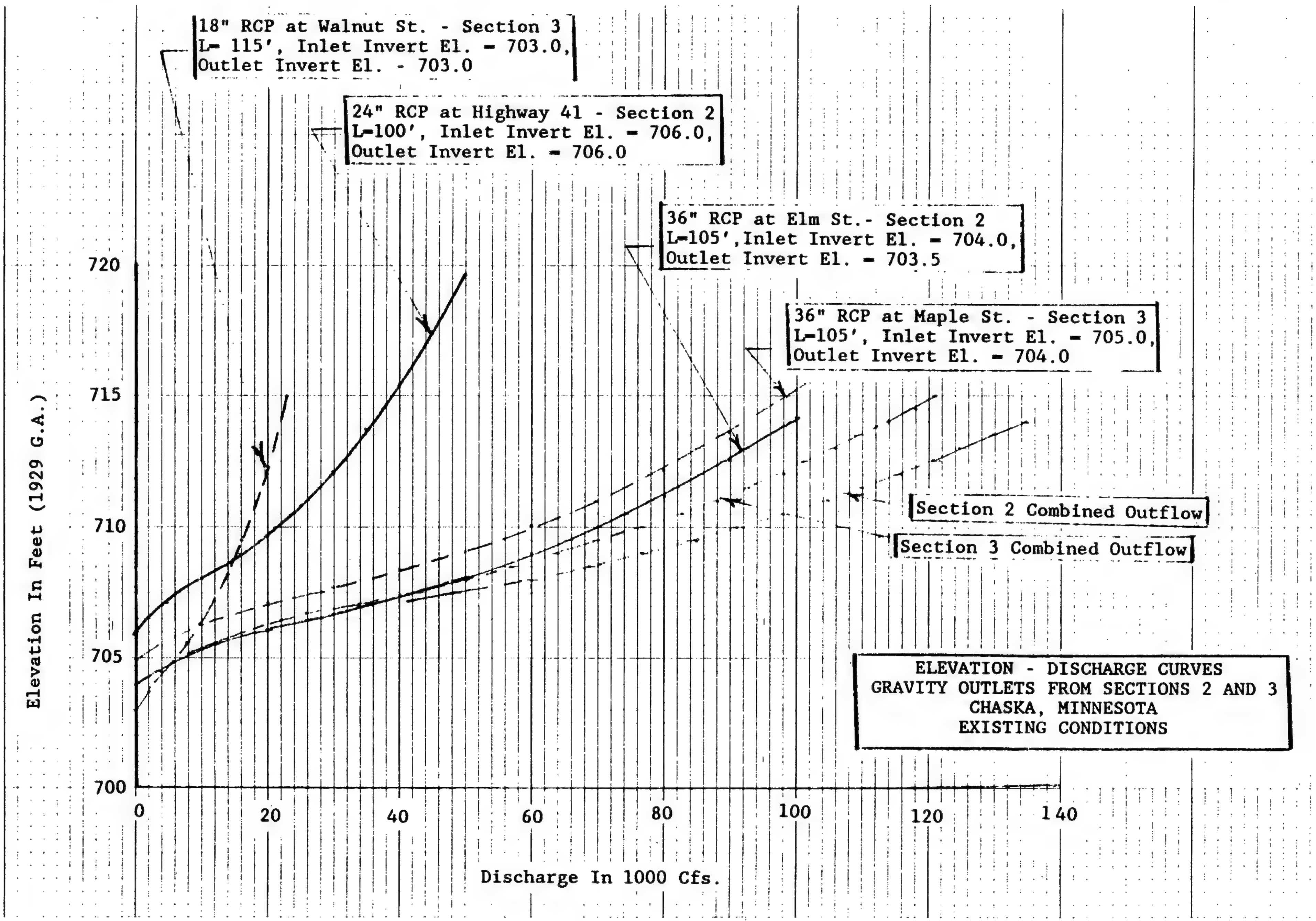


Rainfall Frequency

Annual Frequency Of Occurrence	Percent Chance Of Occurrence
1 - Year	100 - Percent
2.5 -	40 -
5 -	20 -
10 -	10 -
25 -	4 -
50 -	2 -
100 -	1 -

POINT RAINFALL DEPTH - DURATION CURVES
CHASKA, MINNESOTA


724
722
720
718
716
Elevation In Feet
0
5
10
15
20
Discharge In Cfs.
ELEVATION - DISCHARGE CURVE
FOR
EXISTING 24-INCH STORMSEWER
FROM SECTION 1



ELEVATION - DISCHARGE CURVES
GRAVITY OUTLETS FROM SECTIONS 2 AND 3
CHASKA, MINNESOTA
EXISTING CONDITIONS

PLATE A-15

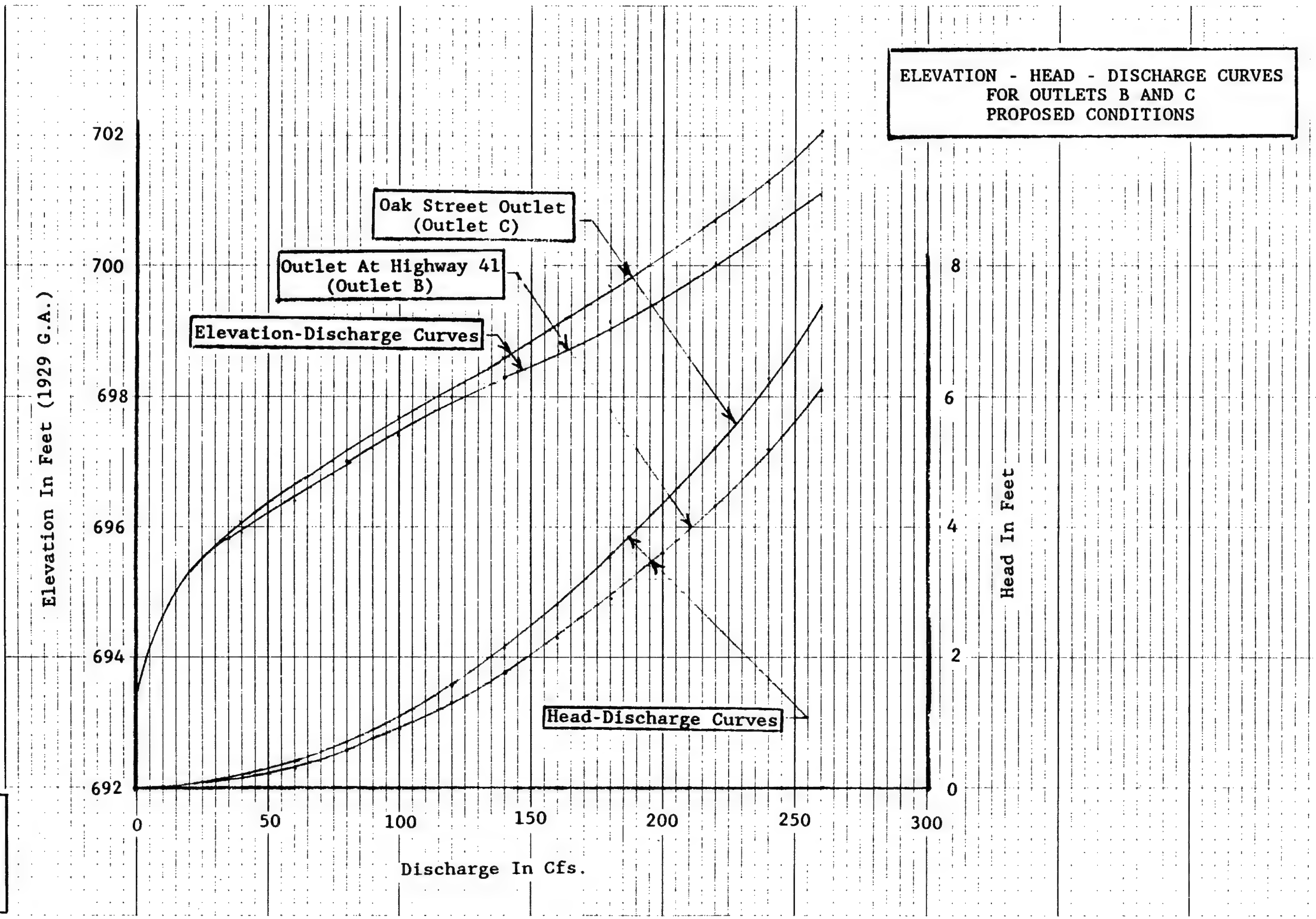
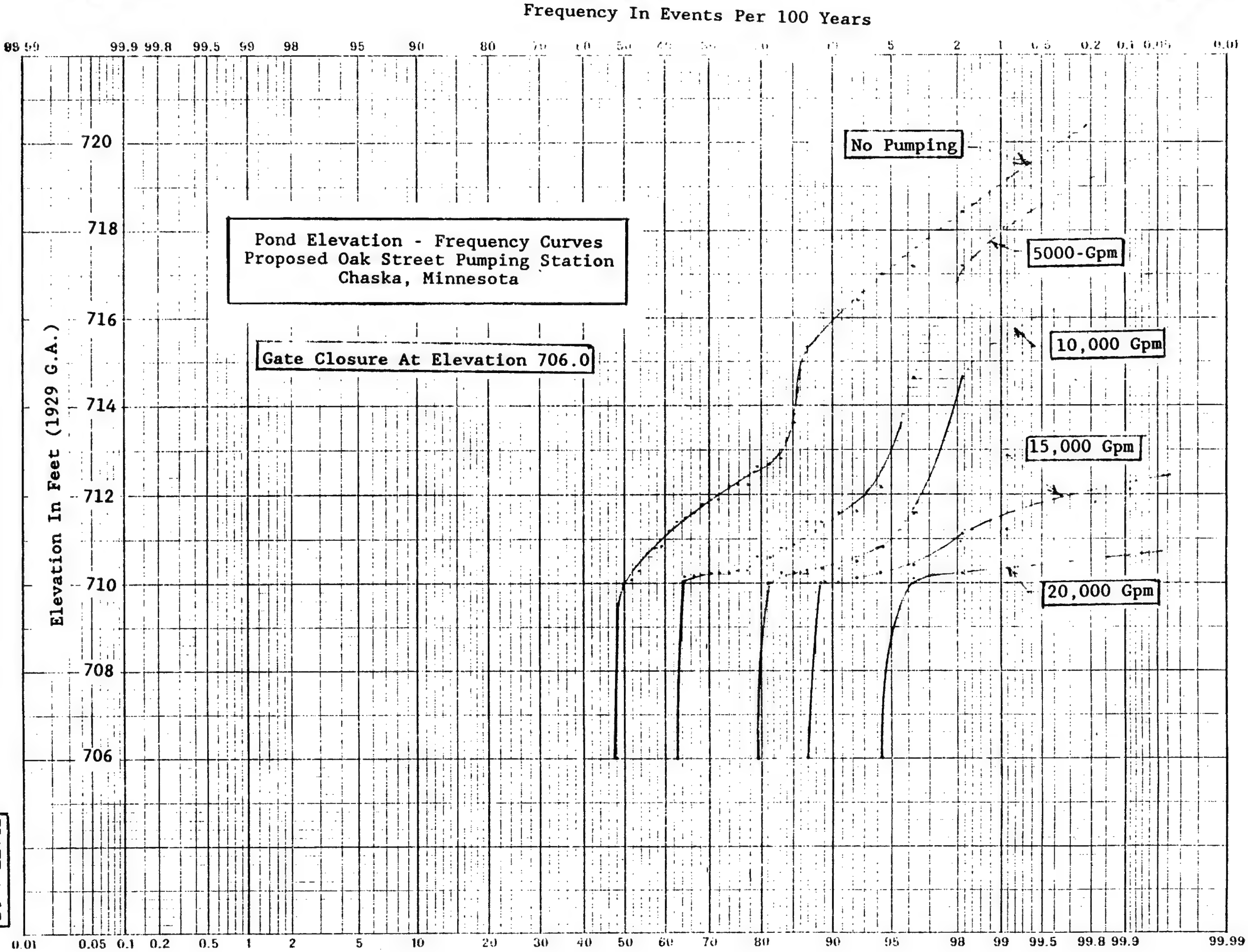
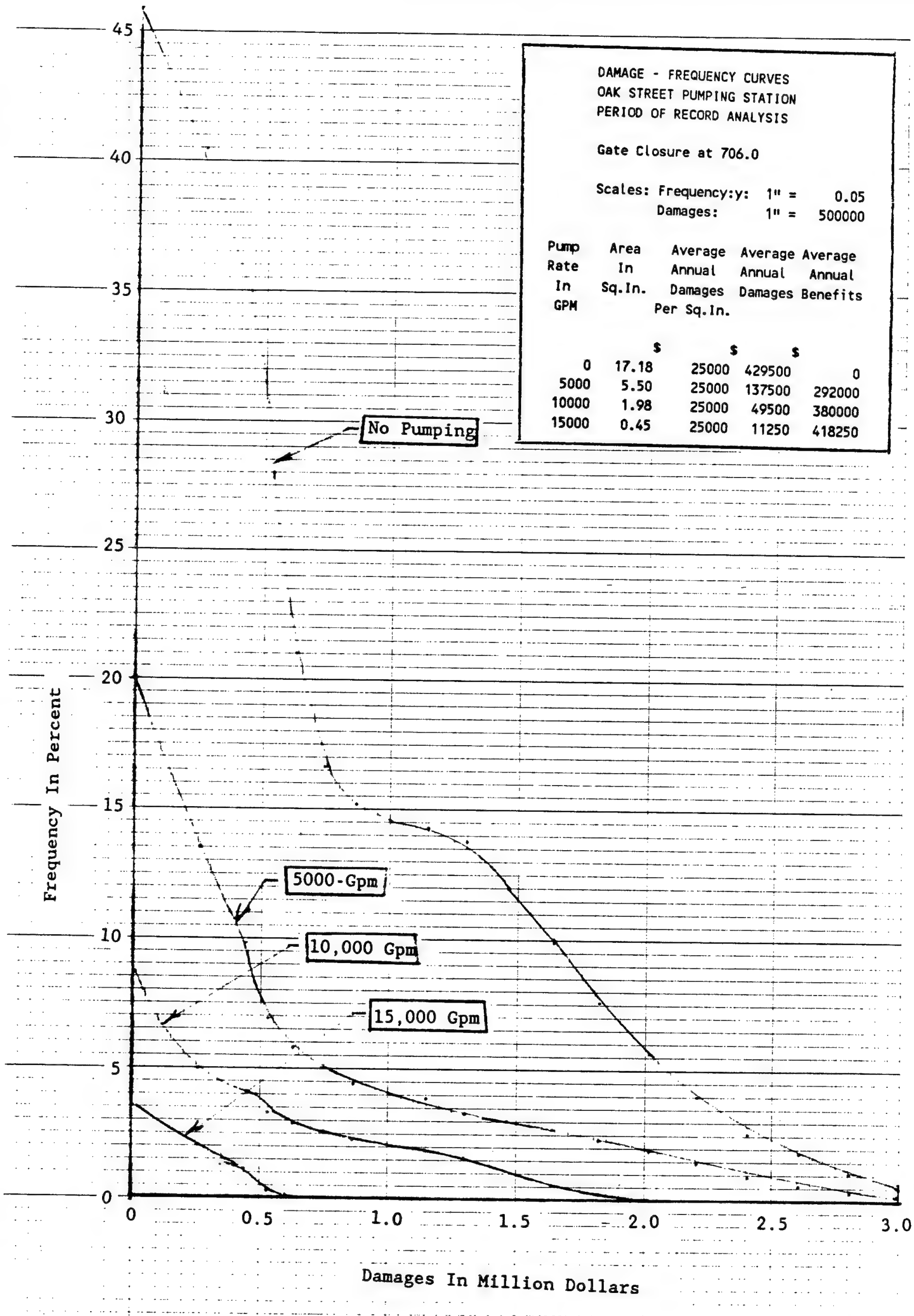

ELEVATION - HEAD - DISCHARGE CURVES
FOR OUTLETS B AND C
PROPOSED CONDITIONS
Oak Street Outlet
(Outlet C)
Outlet At Highway 41
(Outlet B)
Elevation-Discharge Curves
Head-Discharge Curves
Elevation In Feet (1929 G.A.)
702
700
698
696
694
692
Head In Feet
8
6
4
2
0
0
50
100
150
200
250
300
Discharge In Cfs.

PLATE A-16



Frequency In Events Per 100 Years
Elevation In Feet (1929 G.A.)
Pond Elevation - Frequency Curves
Proposed Oak Street Pumping Station
Chaska, Minnesota
Gate Closure At Elevation 706.0
No Pumping
5000-Gpm
10,000 Gpm
15,000 Gpm
20,000 Gpm
720
718
716
714
712
710
708
706
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.5 99.8 99.9 99.99

PLATE A-17



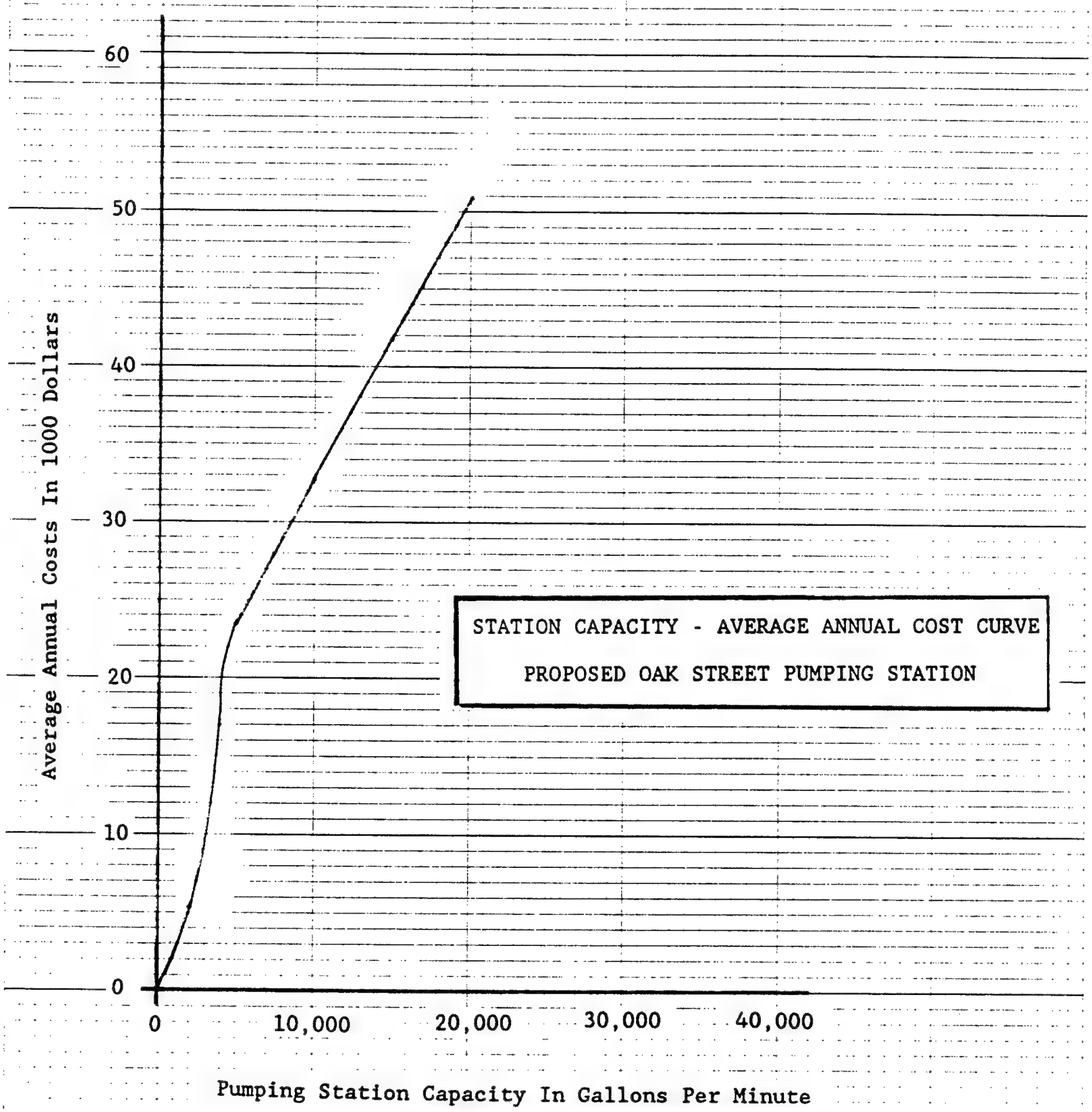
DAMAGE - FREQUENCY CURVES
OAK STREET PUMPING STATION
PERIOD OF RECORD ANALYSIS

Gate Closure at 706.0

Scales: Frequency:y: 1" = 0.05
Damages: 1" = 500000

Pump Rate In GPM	Area In Sq.In.	Average Annual Damages Per Sq.In.	Average Annual Damages	Average Annual Benefits
		$	$	$
0	17.18	25000	429500	0
5000	5.50	25000	137500	292000
10000	1.98	25000	49500	380000
15000	0.45	25000	11250	418250

PLATE A-18



46 0700

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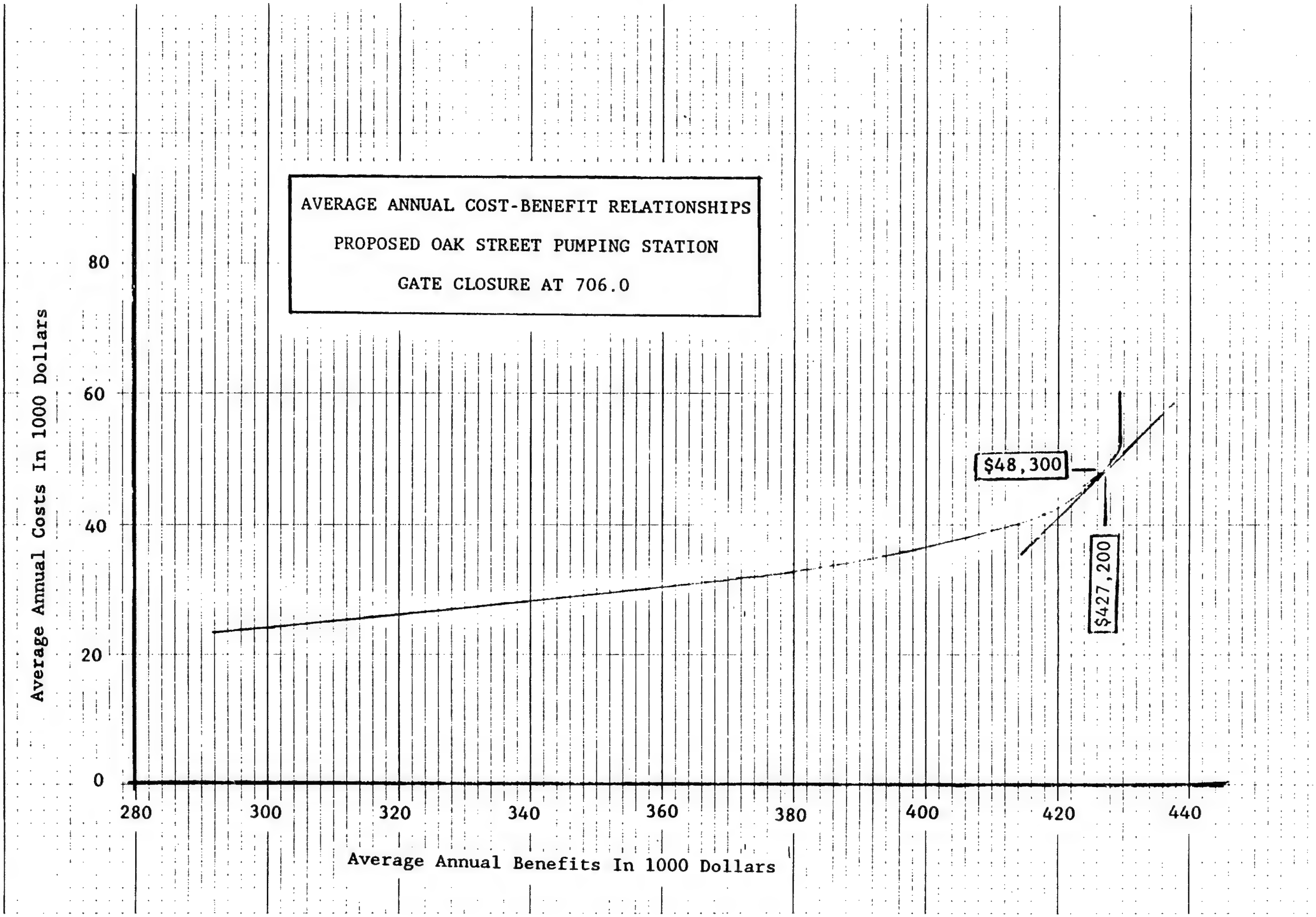
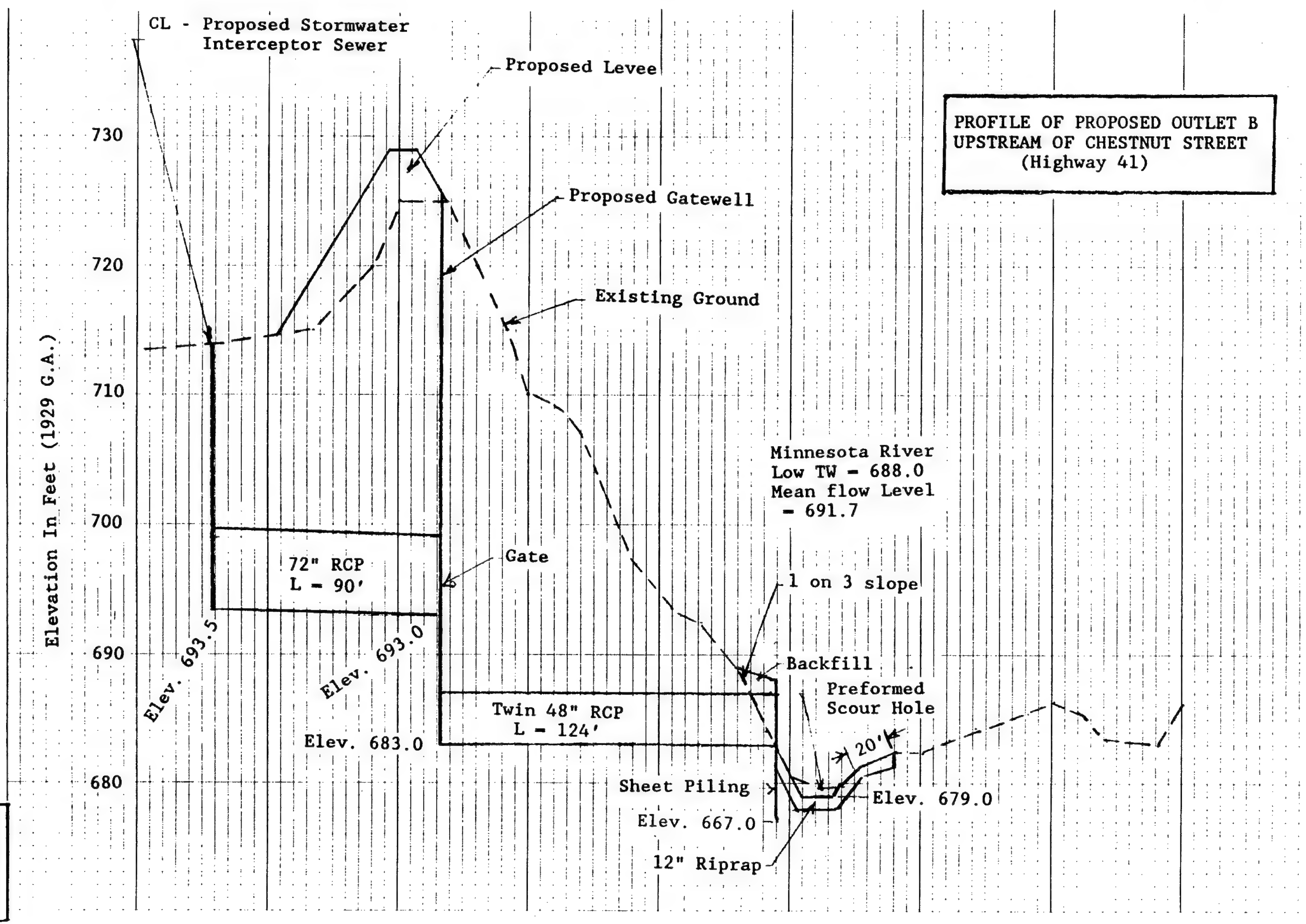
PLATE A-19

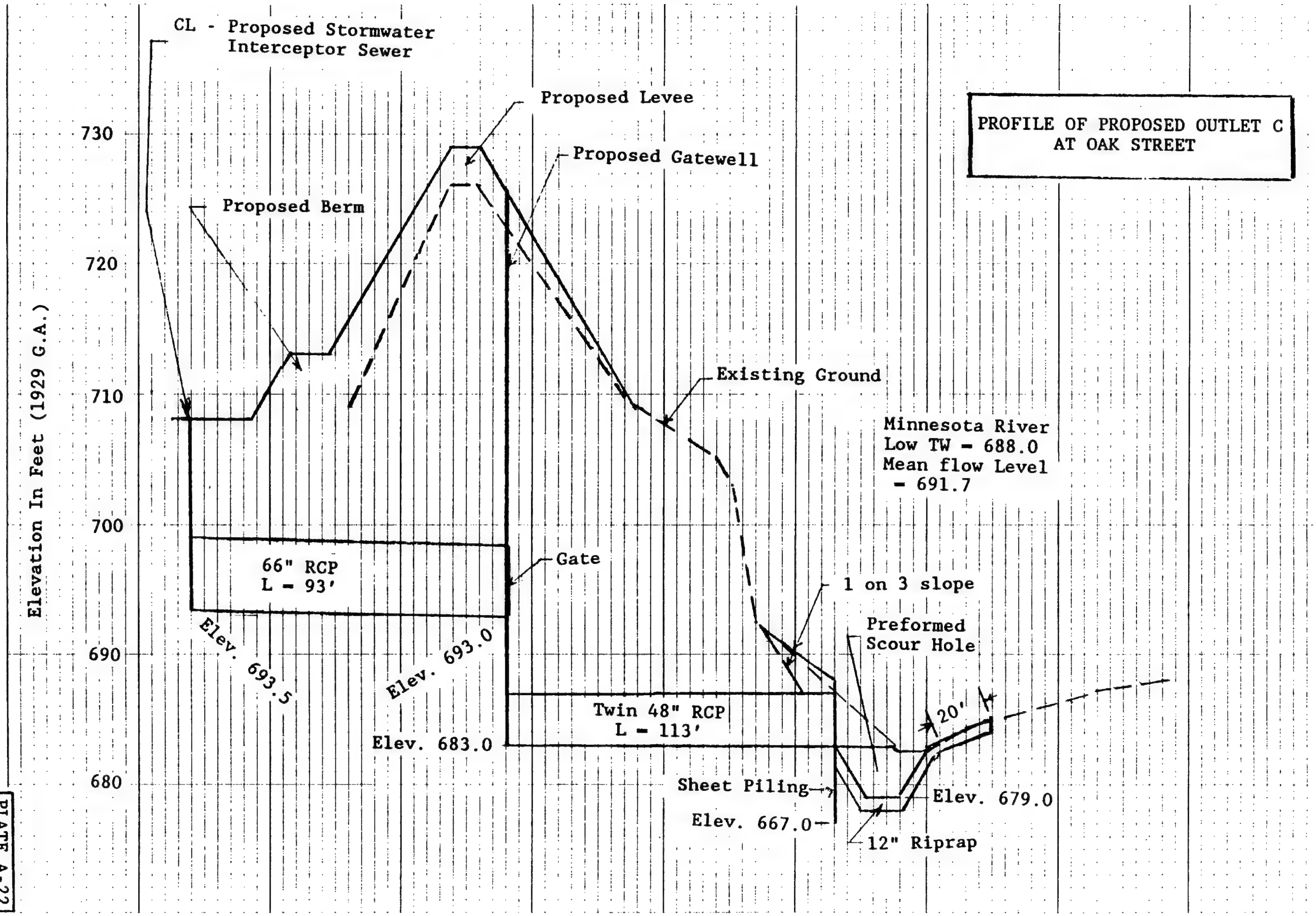


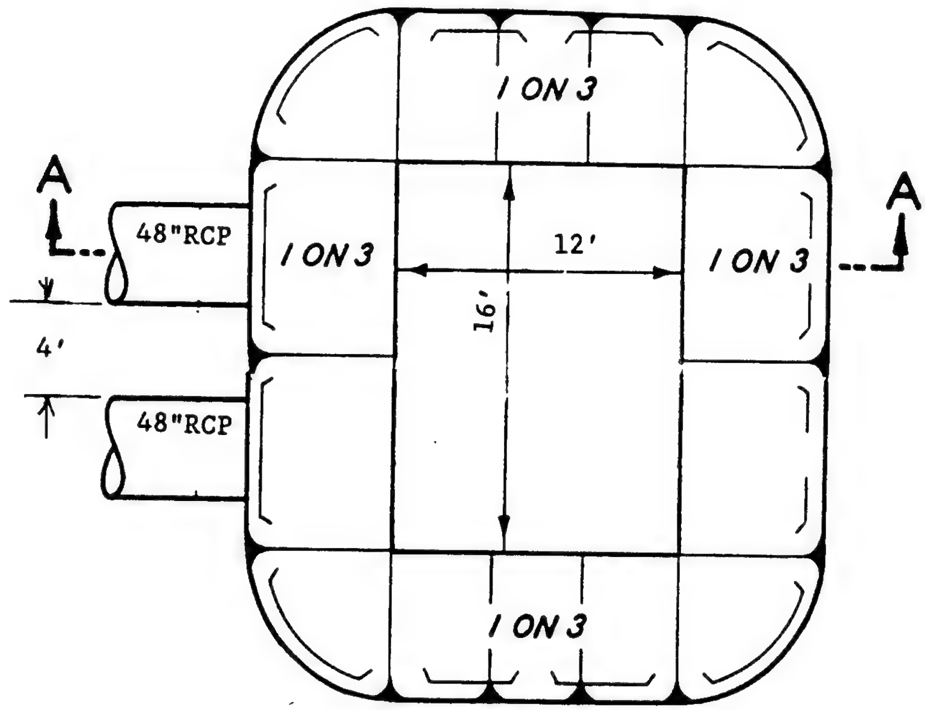
AVERAGE ANNUAL COST-BENEFIT RELATIONSHIPS
PROPOSED OAK STREET PUMPING STATION
GATE CLOSURE AT 706.0
Average Annual Costs In 1000 Dollars
0
20
40
60
80
Average Annual Benefits In 1000 Dollars
280
300
320
340
360
380
400
420
440
$48,300
$427,200


PROFILE OF PROPOSED OUTLET B
UPSTREAM OF CHESTNUT STREET
(Highway 41)
CL - Proposed Stormwater
Interceptor Sewer
Proposed Levee
Proposed Gatewell
Existing Ground
Minnesota River
Low TW - 688.0
Mean flow Level
- 691.7
72" RCP
L - 90'
Gate
1 on 3 slope
Backfill
Preformed
Scour Hole
20'
Twin 48" RCP
L - 124'
Elev. 693.5
Elev. 693.0
Elev. 683.0
Sheet Piling
Elev. 667.0
Elev. 679.0
12" Riprap
730
720
710
700
690
680
Elevation In Feet (1929 G.A.)

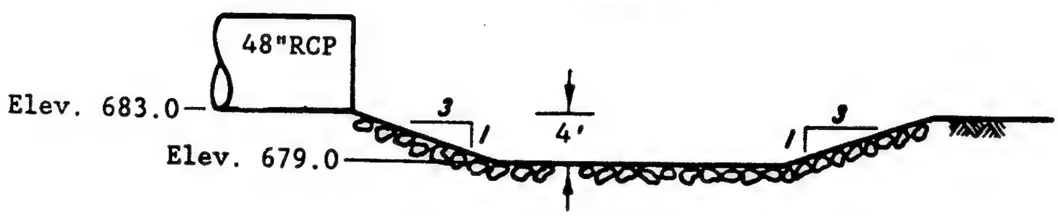
46 0700

PROFILE OF PROPOSED OUTLET C AT OAK STREET





PLAN



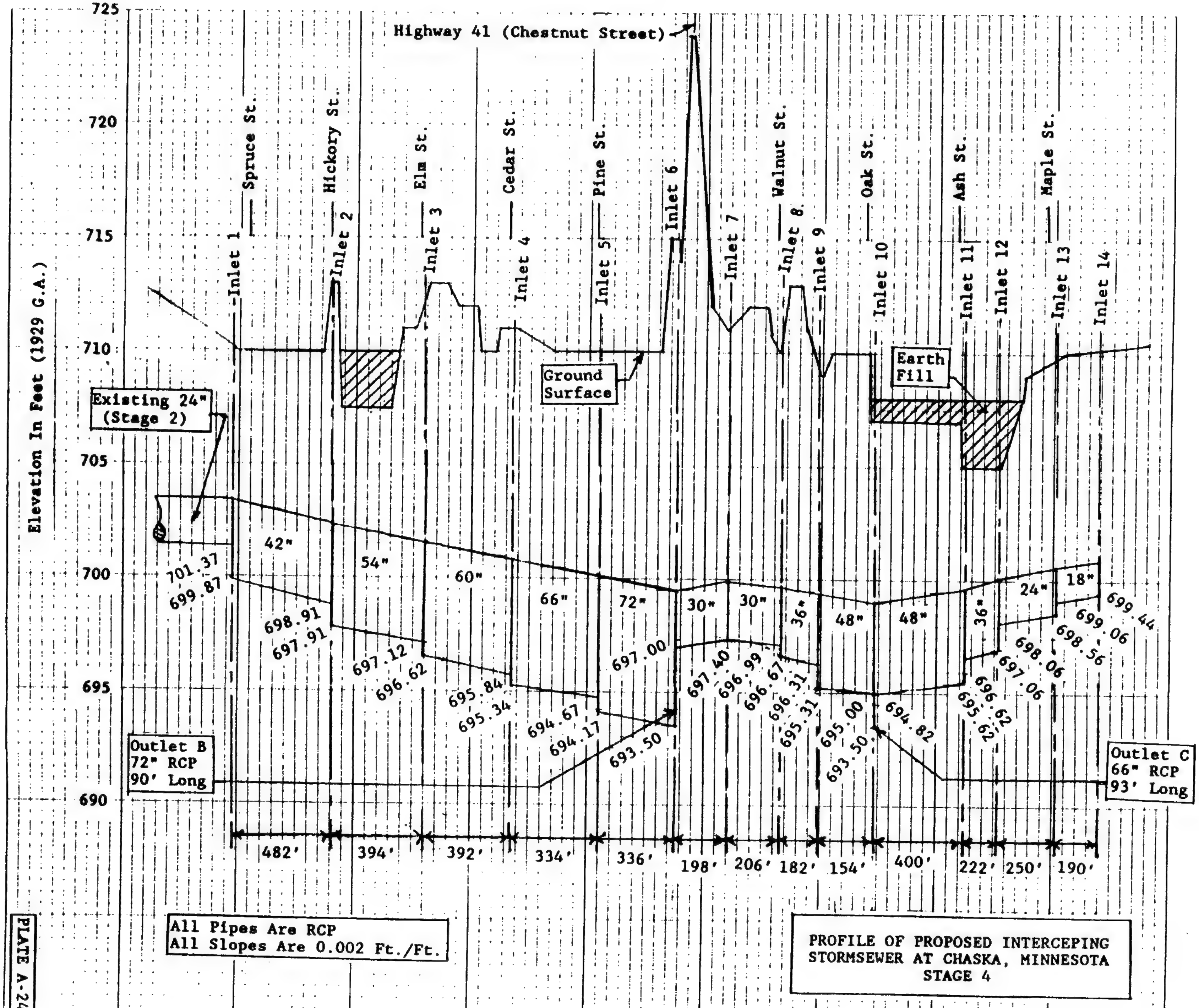
SECTION A-A

Required Riprap Gradation

% Lighter by Weight	Weight Limits Max.	Min.
100	86	35
50	26	17
15	13	5

Thickness - 12 inches

PREFORMED SCOUR HOLE
OUTLETS B AND C
PLAN VIEW



PROFILE OF PROPOSED INTERCEPING STORMSEWER AT CHASKA, MINNESOTA STAGE 4

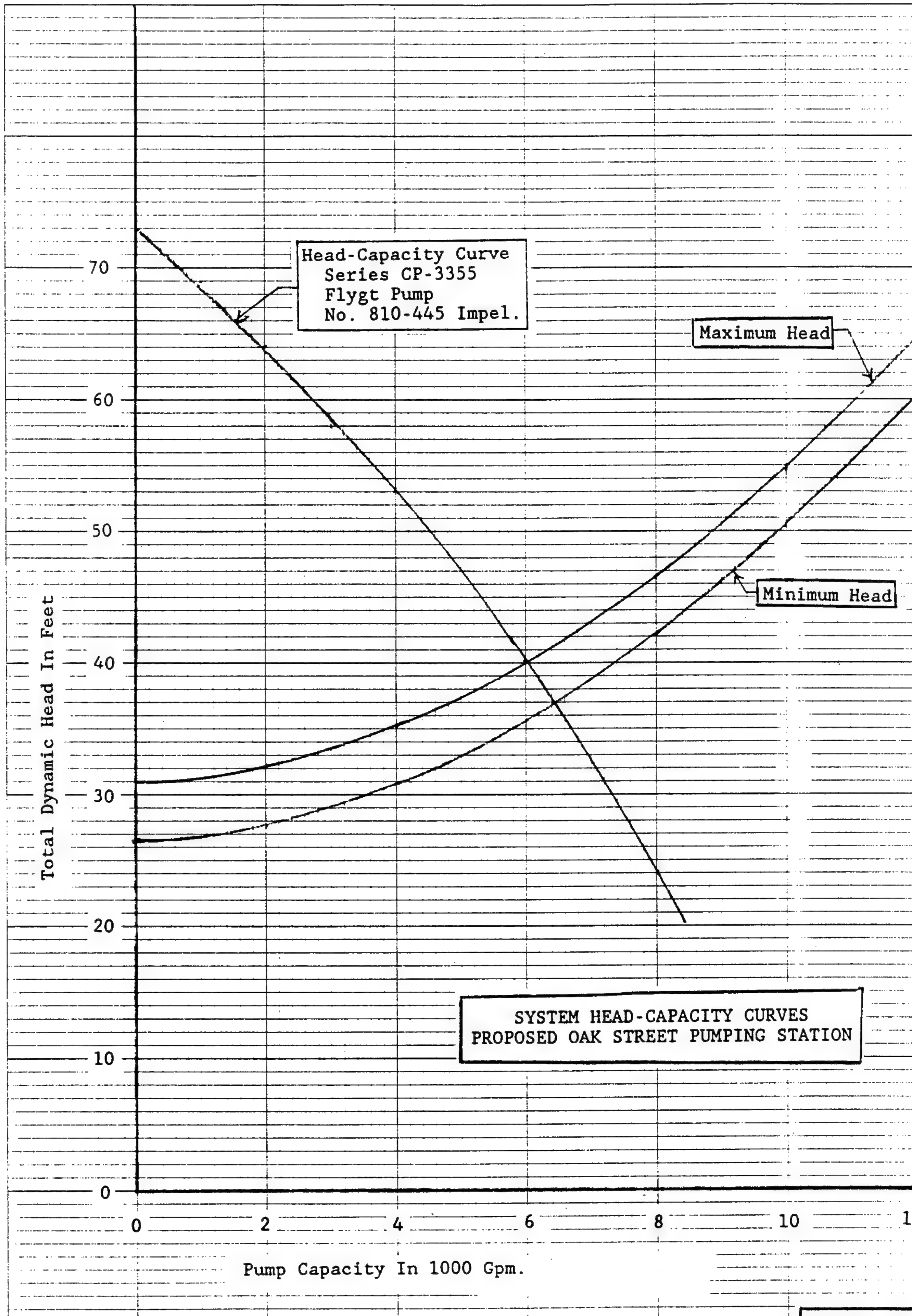


PLATE A-25

10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.
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APPENDIX B

HYDRAULICS

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX B

HYDRAULICS

TABLE OF CONTENTS

Item	Page	Paragraph
PROJECT DESCRIPTION	B-1	1
LEVEL OF PROTECTION AND VARIANCES FROM PREVIOUS PLAN	B-1	3
WATER SURFACE PROFILE COMPUTATIONS	B-2	7
STARTING WATER SURFACE ELEVATIONS	B-4	11
CHANNEL ROUGHNESS DETERMINATION	B-4	13
TOP OF BARRIER DESIGN AND FREEBOARD	B-5	15
ICE AND DEBRIS	B-5	16
PROFILE SENSITIVITY	B-5	17
CHANNEL STABILITY	B-5	18
LEVEE CLOSURES	B-6	19
LEVEE OPENING AT EAST CREEK	B-8	21
EROSION PROTECTION	B-8	23
PRE AND POST-PROJECT CONDITIONS	B-9	25
OPERATION AND MAINTENANCE	B-9	26
REFERENCES	B-11	

TABLES

NUMBER	TITLE	PAGE
1	Water Surface Profile Elevations	B-3
2	Top of Levee Design Computation Minnesota River at Chaska	B-6
3	Comparison of Top of Levee Design Elevations LRR, GDM, and FDM	B-7
4	Riprap Data	B-9

PLATES

B-1, B-2	Minnesota River Cross Section Locations
B-3, B-4	Water Surface Profile Elevations
B-5	Elevation - Discharge Rating Curve
B-6	FN Curve - Scott County FIS
B-7	Top of Levee Elevation
B-8	Levee Opening at East Creek

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX B

HYDRAULICS

PROJECT DESCRIPTION

1. Stage 4 of the Chaska Flood Control Project consists of the construction of approximately 7000 feet of levee along the Minnesota River and construction of interior flood control (IFC) facilities, which include interceptors and a pump station. Approximately 2000 feet of levee was constructed during Stage 2 of the project (making 9000 total feet of levee for the entire project).

2. The main topic of this appendix is the top of barrier design. Much of the analysis was performed prior to Stage 2 construction in order to determine the final levee heights. The IFC facilities are discussed in appendix A. Previous Studies are discussed in the Feasibility Report, the Limited Reevaluation Report (LRR), and the General Design Memorandum (GDM).

LEVEL OF PROTECTION AND VARIANCES FROM PREVIOUS PLAN

3. The level of protection provided by the levee proposed in this appendix is the 1-percent chance flood. The SPF (as defined by the Minnesota Department of Natural Resources) is contained within the levee freeboard. The level of protection provided by the GDM levee was also the 1-percent chance flood, but freeboard was not sufficient to pass the SPF.

4. During review of the GDM report, the Minnesota Department of Natural Resources (MNDNR) expressed concern that the level of protection did not meet their floodplain regulatory requirements; therefore areas landward of the levee would not be removed from the City's regulatory floodplain. The MNDNR's floodplain management (FPM) requirements for removal of areas from the floodplain are:

a.) The levee must provide at least 3 feet of freeboard above the 1-percent chance flood for FPM (with floodway) conditions.

b.) The top of levee must equal or exceed the elevation of the design SPF for FPM (with floodway) conditions. The design SPF is as defined by the MNDNR and includes the effects of potential bridge plugging.

5. After the GDM was published and before this document was written, the Corps performed further hydraulic analysis and compared the Corps' levee design criteria to the criteria used by the MNDNR in their FPM program. That hydraulic analysis was written into a report titled <u>Hydraulic Evaluation of the Degree of Protection and State of Minnesota Floodplain</u>

Management Considerations for the Proposed Minnesota River Levees of the Chaska Flood Control Project, (Reference 5) and will be referred to as the HEDP report. The top of levee design reported in this appendix is an update of the HEDP analysis, and includes discussion of that analysis where necessary. The HEDP and FDM analysis revealed that the extra increment in levee height required to meet MNDNR FPM requirements was very small, approximately two-tenths of a foot on the downstream reach of the levee. Therefore, the levee was raised to meet the MNDNR's requirements.

6. The MNDNR has reviewed the top of levee design presented in this appendix. A letter dated June 6, 1989 from the MNDNR to the Corps (Reference 6) stated "...the increases in levee height that are proposed will insure that the proposed project remains compliant with the State of Minnesota Floodplain Management regulations."

WATER SURFACE PROFILE COMPUTATIONS

7. Water surface profiles for the Minnesota River were computed using an updated HEC-2 computer model of the Lower Minnesota River, originally developed by the United States Geological Survey (USGS) in cooperation with the MNDNR and the Lower Minnesota River Watershed District in 1973. The original model was used to determine flood plain areas of the Lower Minnesota River. The model reach extended from the confluence of the Minnesota River with the Mississippi River upstream through the city of Chaska. This basic model was updated during the LRR analysis, the HEDP report, and this FDM analysis. Cross section locations in the Chaska vicinity are shown on Plate B-1. A typical cross section is shown on Plate B-2.

8. The hydraulic analysis focused on updating the HEDP HEC-2 model. Pertinent corrections to the HEC-2 model were made using original survey data obtained from the USGS, as well as bridge data obtained from the Minnesota Department of Transportation (MNDOT). With this data, the following major corrections were made to the model:

a.) The Cedar Ave. bridge was recoded to represent the new bridge installed since the original model was created.

b.) The 35W bridge was recoded from a special bridge routine to a normal bridge routine.

c.) The railroad bridge between Savage and Bloomington was converted from a special bridge routine to a normal bridge routine.

d.) The abandoned railroad bridge at Chaska was converted from a special bridge routine to a normal bridge routine.

e.) Pedestrian guard rails at the abandoned railroad bridge at Chaska were added.

TABLE 1

WATER SURFACE PROFILE ELEVATIONS
TOP OF LEVEE DESIGN ELEVATIONS
MINNESOTA RIVER AT CHASKA

ALL ELEVATIONS ARE IN NGVD 1929

SECNO	ELMIN	MNDNR FPM 1-PCT CWSEL	MNDNR FPM SPF CWSEL	USACE GDM 1-PCT CWSEL	USACE FDM 1-PCT CWSEL	USACE FDM SPF CWSEL	153000 CFS LEVEE OVERTOP CWSEL	USACE DESIGN TOP OF LEVEE ELEV
70	685.00	723.55	727.47	724.20	724.34	728.32	727.45	727.5
71	659.70	723.64	727.55	724.20	724.44	728.41	727.55	727.9
72.3	672.40	723.58	727.49		724.38	728.36	727.50	
72.4	672.40	723.55	727.48		724.37	728.36	727.49	
72.8	672.40	723.60	727.52		724.42	728.41	727.54	
72.9	672.40	723.84	727.60		724.60	728.41	727.60	
73	669.90	724.36	728.15	724.80	725.06	728.89	728.08	728.5
74	685.30	724.55	728.36	724.90	725.26	729.11	728.29	728.7
75	674.90	724.66	728.49	725.10	725.37	729.24	728.42	728.9
75.4	674.90	724.67	728.49		725.38	729.25	728.42	
76	674.30	724.64	728.47		725.36	729.23	728.40	
76.2	674.30	724.65	728.47		725.37	729.23	728.41	
76.8	674.30	724.83	728.66		725.52	729.39	728.57	
77	680.10	724.84	728.67	725.30	725.53	729.40	728.58	729.1
78	686.60	724.94	728.77	725.40	725.63	729.51	728.68	729.2

NOTE: The discharges and the FN values (J2.6 of the HEC-2 model) are shown below.

Flood Event	Design and FPM Discharge	Design FN	FPM FN
1-PCT	115,000 cfs	1.1	1.0
SPF	165,000 cfs	1.0	0.91

f.) The Minnesota River levee encroachments at Chaska were added.

9. Correction "d" had the largest impact on the water surface profiles at Chaska, increasing the design 1-percent chance water surface profile approximately 0.4 feet and the design SPF profile approximately 0.2 feet above the profiles computed for the HEDP report. The other corrections

caused an approximate 0.1 foot accumulative increase in the water surface profiles.

10. A table of water surface profiles for the 1-percent chance flood and SPF in the city of Chaska are shown on Table 1. The table shows water surface profile elevations for both Corps' criteria and the MNDNR' criteria. Plotted water surface profiles are shown on Plates B-3 and B-4.

STARTING WATER SURFACE ELEVATIONS

11. Starting water surface elevations for the Minnesota River at its junction with the Mississippi River are based on the elevation-discharge rating curve for the Mississippi River shown on Plate B-5. The curves were developed from data from the October 1972 Mississippi River Flood Plain Information (FPI) report and the MDNR's subsequent floodway analysis.

12. Starting water surface elevations were determined from this rating curve by assuming that low exceedance frequency events occur coincidentally on both the Minnesota and Mississippi Rivers. For example, the starting water surface elevation for the 1-percent chance flood on the Minnesota River is determined from backwater computations for the 1-percent chance flood on the Mississippi River. The starting water surface elevation for the SPF discharge on the Minnesota River (which corresponds to a 0.27-percent chance flood on the Mississippi), is determined from backwater computations for a 194,000 CFS discharge on the Mississippi (the discharge for a 0.27-percent chance event on the Mississippi).

CHANNEL ROUGHNESS DETERMINATION

13. Manning's "n" values for existing conditions were determined by the USGS during the Lower Minnesota Flood Plain study of 1973. This original HEC-2 study model was calibrated using high-water mark data from the 1969 flood, which is the second largest flood of record and approximates a 2-percent chance exceedance frequency event in the city of Chaska. Manning's "n" values for this original study were not varied with discharge. However, during the HEDP evaluation, "n" values were adjusted for discharge according to the percentages shown on the FN curve on Plate B-6 (FN is variable J2.6 of the HEC-2 model). This curve was developed from observed "n" value discharge relationships for the 1965 flood (113,400 cfs), 1969 flood (84,600 cfs), and 1984 flood (43,800 cfs) for the Minnesota River in Scott County, Minnesota.

14. The existing conditions FN curve was increased by ten percent to establish the design (future) conditions FN curve. This latter curve was used to adjust the original USGS "n" values for the proposed design water surface profile computations.

TOP OF BARRIER DESIGN AND FREEBOARD

15. The proposed top of levee elevations are listed in Table 1 and shown on Plate B-7. These elevations were determined by adding 3 feet of freeboard to the Corps' design 1-percent chance flood profile and providing an additional increment of freeboard as described in Reference 4. This "superiority freeboard" assures that overtopping occurs in the least critical area, which is the downstream end of the levee. An additional two-tenths of a foot were added at the the very downstream end of the levee to satisfy MNDNR requirements as listed in paragraph 2. Table 2 gives the computation procedure for computing the top of levee elevations. Table 3 compares the top of levee elevations from the LRR, GDM, and the FDM.

ICE AND DEBRIS

16. The effects of ice and debris plugging at the bridges were determined to have a negligible effect on the water surface profiles. Therefore plugging was not assumed in the top of levee design.

PROFILE SENSITIVITY

17. Water surface profiles are stable and are not highly sensitive vertically to changes or modifications of the floodplain. (However, a small change in the vertical will backwater for several thousand feet upstream, but is not the critical element in the sensitivity analysis.) During the analysis of water surface profiles, modifications to the abandoned railroad embankment which crosses the floodplain were examined as a means of reducing the levee heights. Water surface profiles were computed with the embankment (which is currently a park trail) lowered to an elevation equivalent to the surrounding floodplain. The effect on the computed profiles was negligible. Other corrections and/or tests made to the model as described in sections 3 and 7 of this appendix indicate that the profiles are not highly sensitive in the vertical direction.

CHANNEL STABILITY

18. Examination of photographs going back 25 years indicates the river channel in the Chaska vicinity is relatively stable, and there is very little potential of significant channel meandering occuring in the near future. Channel erosion occuring at the Hwy 41 bridge is addressed in the EROSION PROTECTION section of this appendix. Channel aggradation has been observed in the Mankato area, upstream of Chaska. However, channel aggradation in the Chaska area will have little effect on water surface profiles of the larger events because of the wide floodplain in the area.

TABLE 2

TOP OF LEVEE DESIGN COMPUTATIONS
MINNESOTA RIVER AT CHASKA

ALL ELEVATIONS ARE IN NGVD 1929

		1	2	3	4	5	6
SECNO	XLCH FEET	USACE FDM 1-PCT CWSEL	1-PCT CWSEL PLUS 3 FEET	153000 CFS LEVEE OVERTOP CWSEL	LEVEE ELEV WITH SUPER-IORITY	MNDNR FPM SPF CWSEL	USACE DESIGN TOP OF LEVEE ELEV
70	3110	724.34	727.34	727.45	727.3	727.47	727.5
71	970	724.44	727.44	727.55	727.9	727.55	727.9
72.3	70	724.38	727.38	727.50		727.49	
72.4	5	724.37	727.37	727.49		727.48	
72.8	30	724.42	727.42	727.54		727.52	
72.9	5	724.60	727.60	727.60		727.60	
73	40	725.06	728.06	728.08	728.5	728.15	728.5
74	3090	725.26	728.26	728.29	728.7	728.36	728.7
75	1450	725.37	728.37	728.42	728.9	728.49	728.9
75.4	52	725.38	728.38	728.42		728.49	
76	10	725.36	728.36	728.40		728.47	
76.2	38	725.37	728.37	728.41		728.47	
76.8	10	725.52	728.52	728.57		728.66	
77	50	725.53	728.53	728.58	729.1	728.67	729.1
78	4120	725.63	728.63	728.77	729.2	728.68	729.2

NOTE: Column 4 would normally be the Corps' recommended design elevation for top of levee. However, because of the MNDNR flood plain regulation requirements, column 6 contains the recommended design elevations. Note the only difference between the levee elevations in columns 4 and 6 is that 0.2 feet were added to the levee at secno 70 to meet MNDNR requirements.

LEVEE CLOSURES

19. A levee closure will be required at the intersection of the levee with Highway 41. The elevation of the top of road at this intersection is approximately 725.4 feet. The maximum closure height is approximately 3.7 feet, which is essentially in the levee freeboard (freeboard is 3.6 feet at

TABLE 3

COMPARISON OF TOP OF LEVEE DESIGN ELEVATIONS
LRR, GDM, AND FDM

ALL ELEVATIONS ARE IN NGVD 1929

SECNO	USGS R-MILE	LRR TOP OF LEVEE ELEV	GDM TOP OF LEVEE ELEV	FDM TOP OF LEVEE ELEV	FLOOD PROFILE FOR Q = 153000	SUPERIORITY FREEBOARD FEET	TOTAL FREE-BOARD FEET
70	27.86	727.38	727.50	727.5	727.45	0.0	3.0
71	28.04	727.48	727.50	727.9	727.55	0.3	3.3
72.3	28.06	bridge			727.50		
72.4	28.06	bridge			727.49		
72.8	28.06	bridge			727.54		
72.9	28.06	bridge			727.60		
73	28.07	728.38	727.50	728.5	728.08	0.4	3.4
74	28.66	728.56	728.00	728.7	728.29	0.4	3.4
75	28.93	728.69	728.00	728.9	728.42	0.5	3.5
75.4	28.94	bridge			728.42		
76	28.94	bridge			728.40		
76.2	28.95	bridge			728.41		
76.8	28.95	bridge			728.57		
77	28.96	728.91	728.50	729.1	728.58	0.5	3.5
78	29.74	729.02	729.00	729.2	728.68	0.5	3.5

the closure). A stop log closure will not be required because the closure is essentially in the freeboard range and ample time should be available to construct a sandbag closure. During the 1965 flood of record, the river rose at a relatively rapid rate of 0.2-0.3 foot per hour. Assuming a similar rate of rise and sandbag mobilization begins when the river is 3 feet from the closure, 15 hours would be available to construct the first foot of closure. For each foot of closure constructed, an additional 5 hours of time would be available to construct the next foot. The 1969 flood did not rise this rapidly; therefore the 1965 flood rate of rise could be considered a possible yet conservative scenario for future floods.

20. The levee closure will only be required for events that approach the 1-percent chance flood. Therefore the frequency of closure will be quite rare. Neither the 1965 or 1969 floods reached the critical elevation of the closure of 725.4.

LEVEE OPENING AT EAST CREEK

21. The East Creek Diversion design (Stage 3 of the Chaska Flood Control Project) is not final at this writing. The diversion channel design will affect the size of hydraulic structure required to pass East Creek flows through the levee and into the Minnesota River. Therefore, the levee will be left open at the East Creek intersection. The required structure will be designed and constructed during Stage 3 FDM analysis.

22. The recommended opening in the levee allows 30 feet between the toe of the levee and the left and right channel banks of the creek. The levee opening is sloped back at a 3H:1V side slope from the toe to top of levee. See Plate B-8 for a sketch of the opening.

EROSION PROTECTION

23. Erosion is currently occurring on the left bank immediately downstream of the Highway 41 bridge. The river takes a sharp bend upstream of the bridge, causing higher velocities and eddies to impinge upon this bank. The toe of the levee will project somewhat farther into the main channel, requiring armoring with riprap both upstream and downstream of the bridge.

24. The riprap computations were based on HL-88-4 and revealed that only a 12 inch layer thickness was required. However, an 18 inch layer is recommended for the following reasons:

a.) The sharp bend upstream of the bridge causing ice and debris to impinge on the bank.

b.) The presence of the bridge at the location of the sharp channel bend creating undefinable flow patterns.

c.) The riprapped area will be along a public walking trail creating easy access for vandalism.

The riprap gradation and other pertinent data is shown on Table 4. Maximum velocities in the main channel occur at approximately 50,000 cfs; therefore this discharge was used for the riprap design. The area of the left bank to be riprapped extends from approximately 100 feet upstream of the bridge to approximately 300 feet downstream of the bridge. Because the bridge may create erosive flow patterns for flows higher than 50,000 cfs, the riprap will be carried to the design flood elevation of 725.4. The layer thickness will be increased by 50 percent where underwater placement will be required.

TABLE 4

RIPRAP DATA
MINNESOTA RIVER AT CHASKA

DESIGN DATA

Riprap design discharge	=	50,000 CFS	
Average channel velocity	=	3.6 FPS	
Channel design velocity	=	5.4 FPS	(avg. vel. X 1.5)
Channel velocity at toe	=	10.9 FPS	

RIPRAP GRADATION

d100(max) = 18 in.
d30(min) = 0.73 ft.
d90(min) = 1.06 ft.
layer thickness = 18 in.
(increase by 50% for underwater placement)
top of riprap elevation = 725.4 ft.

PCT LIGHTER BY WEIGHT	LIMITS OF STONE WEIGHT, LBS MAX	MIN
100	292	117
50	86	58
15	43	18

PRE- AND POST-PROJECT CONDITIONS

25. Construction of the flood barrier as proposed in this report will have no effect on river conditions either upstream or downstream of the project. The levee will not impact water surface profiles, velocities, or channel aggradation when compared to pre-project conditions. No other future impacts are foreseen.

OPERATION AND MAINTENANCE

26. Periodic inspections and warranted repairs of the levee will be required to insure its structural integrity and functionability during the life of the project. The sandbag closure will be required during events approaching the 1-percent chance flood. The levee opening at the East Creek intersection will prevent the levee system from being completely

functional until Stage 3 construction completes that portion of the levee. The city may want to develop a contingency plan for emergency closure and control of interior flooding for floods on the river during the interim period between Stage 4 and Stage 3 construction.

REFERENCES

1. Corps of Engineers. 1973. Feasibility Report for Flood Control. Minnesota River at Chaska, Minnesota. U.S. Army Corps of Engineers, St. Paul District, Minnesota.

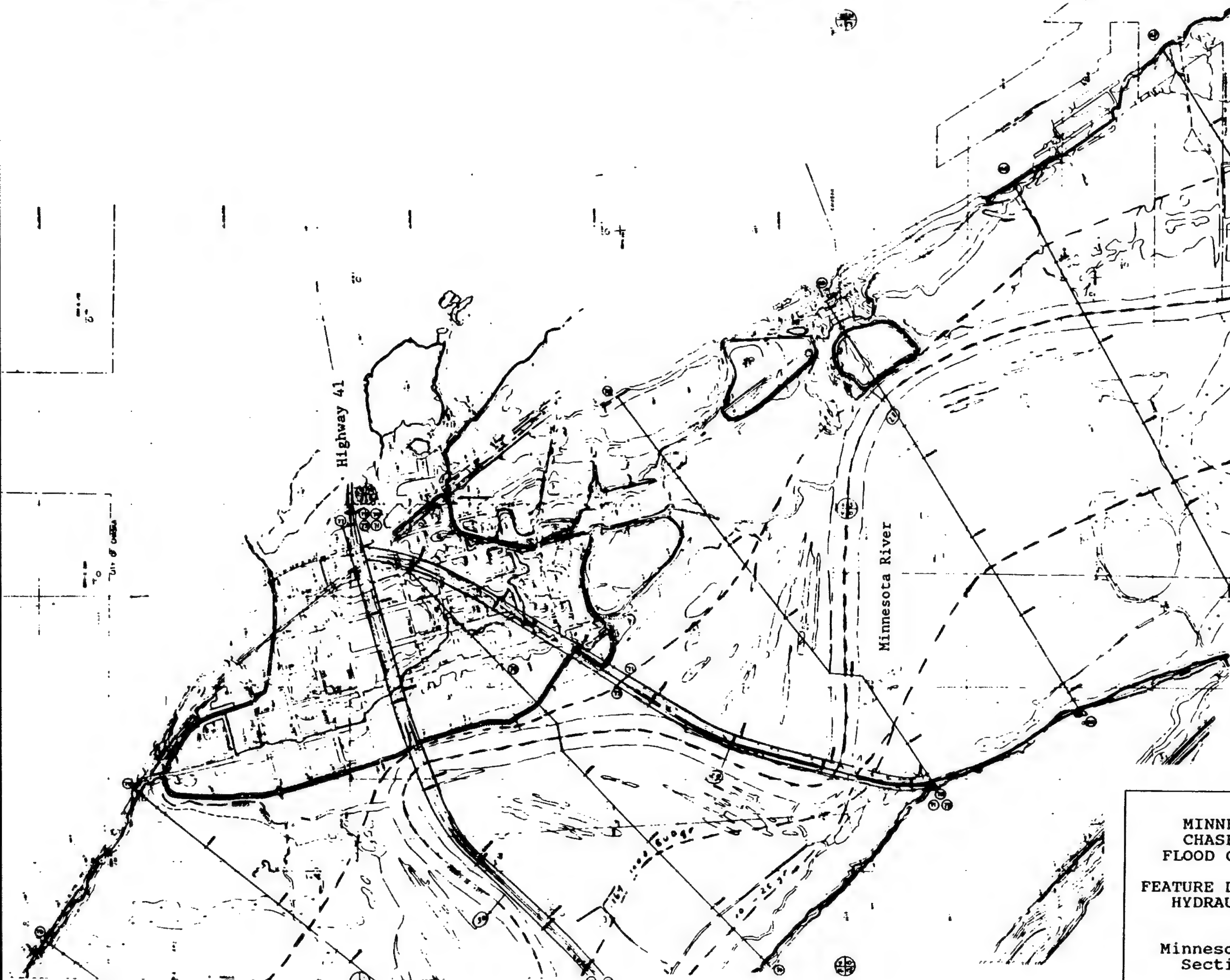
2. Corps of Engineers. 1982. Limited Reevaluation Report and Final Supplement to the Final Environmental Impact Statement for Flood Control and Related Purposes. Minnesota River at Chaska, Minnesota. U.S. Army Corps of Engineers, St. Paul District, Minnesota

3. Corps of Engineers. 1984. General Design Memorandum and Draft Supplement II to the Final Environmental Impact Statement. Minnesota River at Chaska, Minnesota. U.S. Army Corps of Engineers, St. Paul District, Minnesota

4. Corps of Engineers. August 22, 1986. ETL 1110-2-299, Overtopping of Flood Control Levees and Floodwalls. U.S. Army Corps of Engineers, Washington, DC

5. Corps of Engineers. 1987. Hydraulic Evaluation of the Degree of Protection and State of Minnesota Floodplain Management Considerations for the Proposed Minnesota River Levees of the Chaska Flood Control Project. Minnesota River at Chaska, Minnesota. U.S. Army Corps of Engineers, St. Paul District, Minnesota

6. Minnesota Department of Natural Resources. June 6, 1989. Letter from Ronald D. Harnack, MNDNR, to Robert F. Post, USACE.

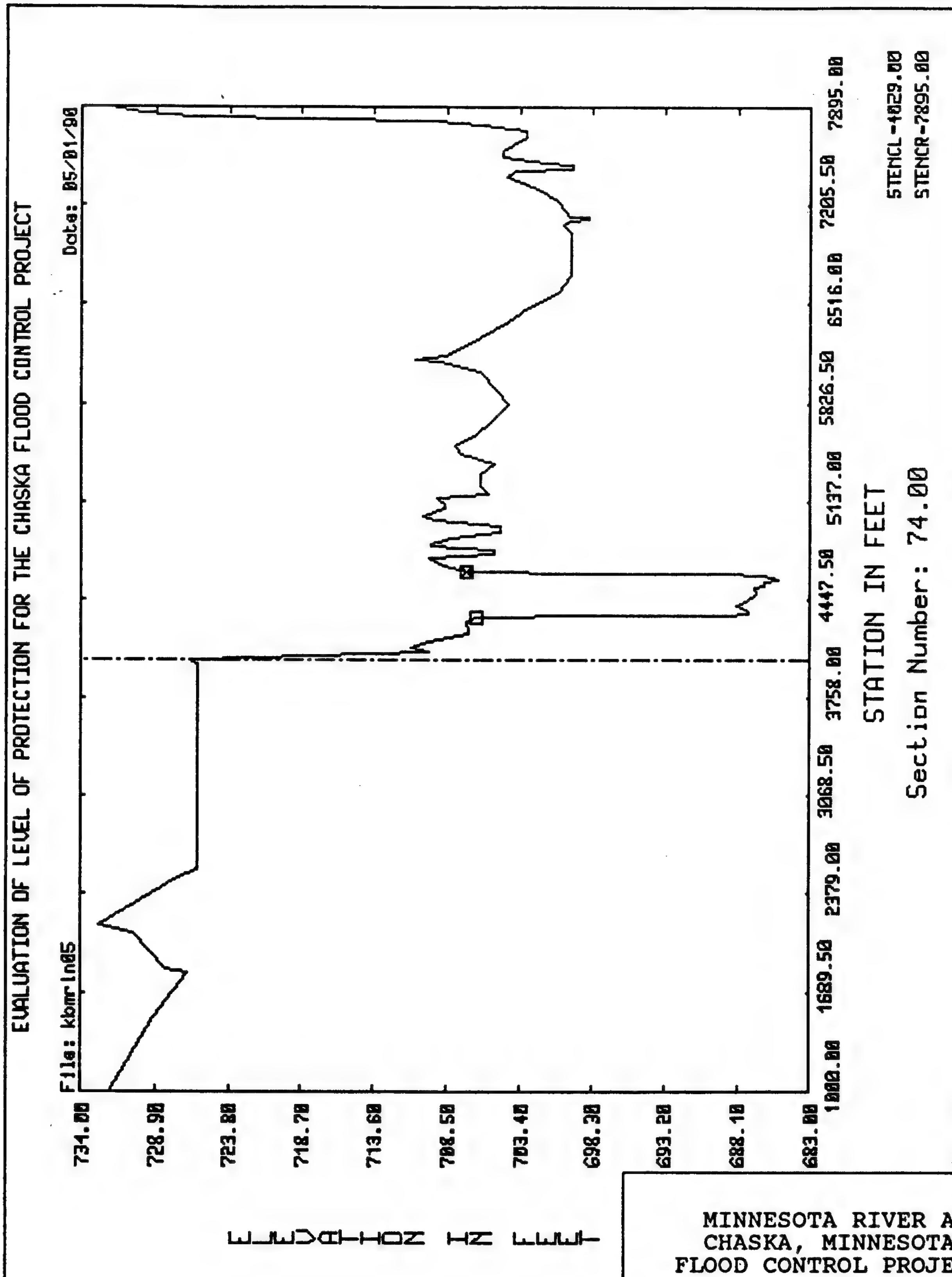


MINNESOTA RIVER AT
CHASKA, MINNESOTA
FLOOD CONTROL PROJECT

FEATURE DESIGN MEMORANDUM
HYDRAULICS APPENDIX

Minnesota River Cross
Section Locations

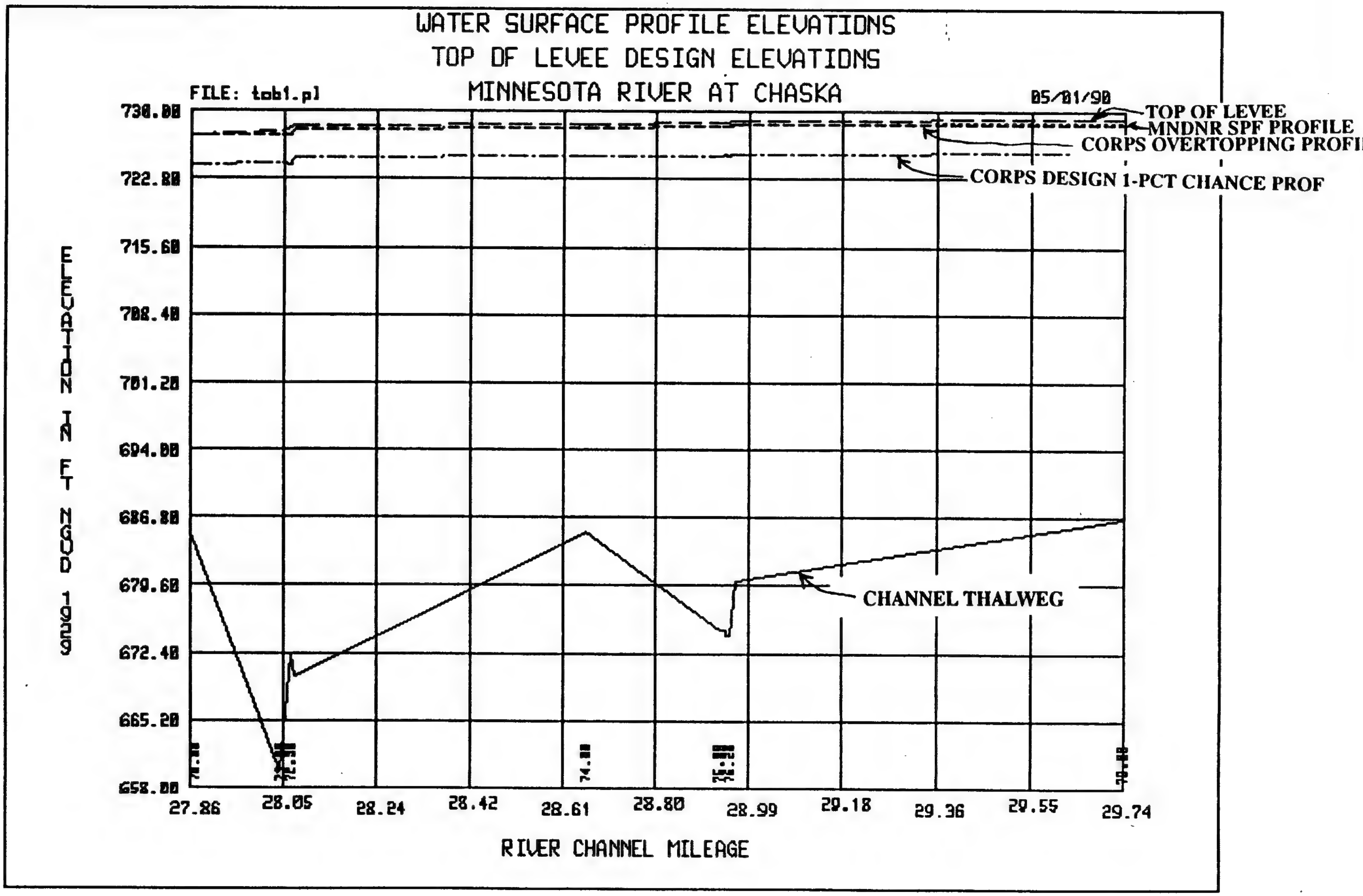
PLATE B-1



MINNESOTA RIVER AT
CHASKA, MINNESOTA
FLOOD CONTROL PROJECT

FEATURE DESIGN MEMORANDUM
HYDRAULICS APPENDIX

Minnesota River
Typical Cross Section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TOP OF LEVEE DESIGN ELEVATIONS
MINNESOTA RIVER AT CHASKA
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05/01/90
TOP OF LEVEE
MNDNR SPF PROFILE
CORPS OVERTOPPING PROFIL
CORPS DESIGN 1-PCT CHANCE PROF
CHANNEL THALWEG
ELEVATION IN FT NGVD 1929
730.00
722.80
715.60
708.40
701.20
694.00
686.80
679.60
672.40
665.20
658.00
27.86
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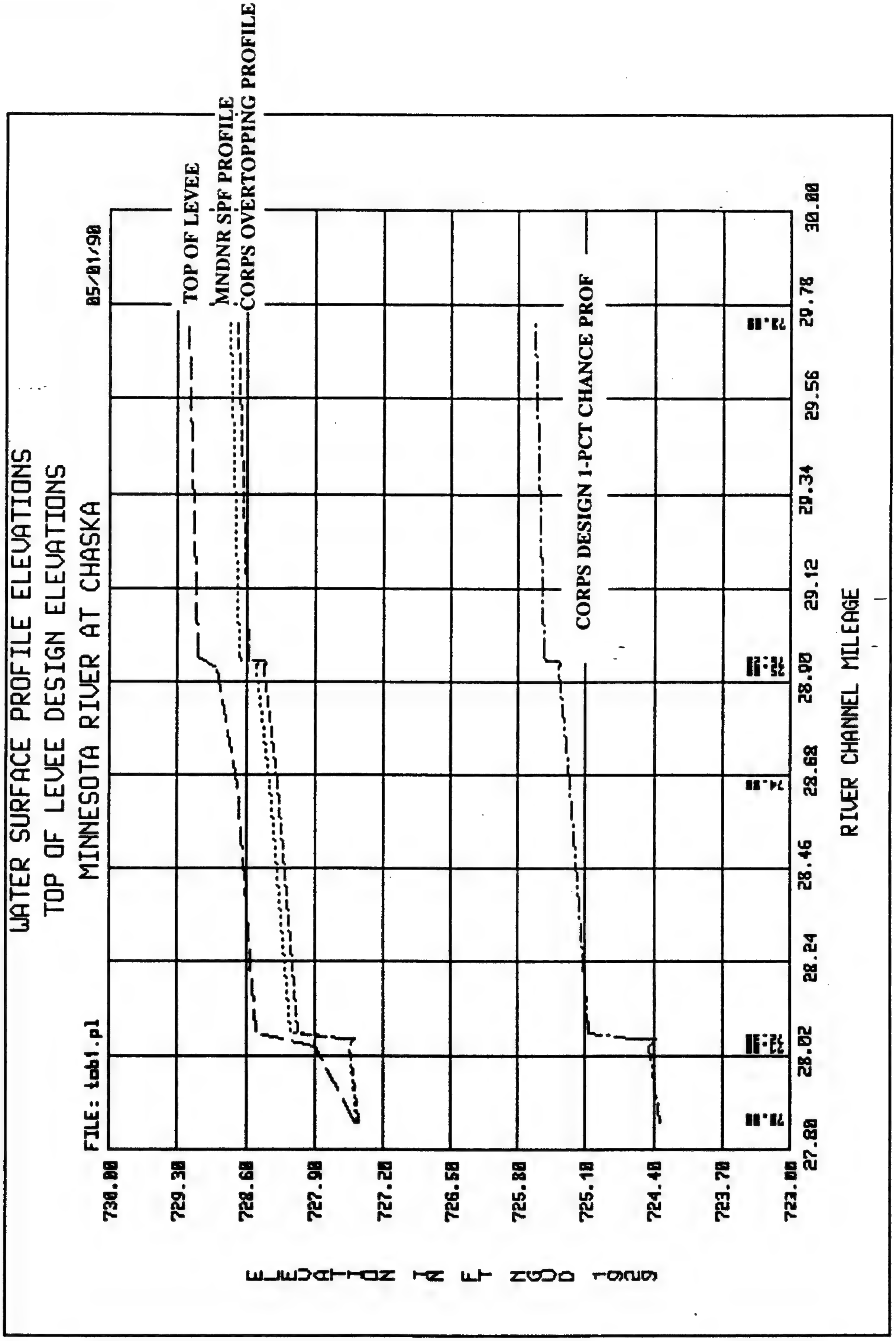
RIVER CHANNEL MILEAGE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CORPS OVERTOPPING PROFILE
CORPS DESIGN 1-PCT CHANCE PROF
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725.10
724.40
723.70
723.00
27.80
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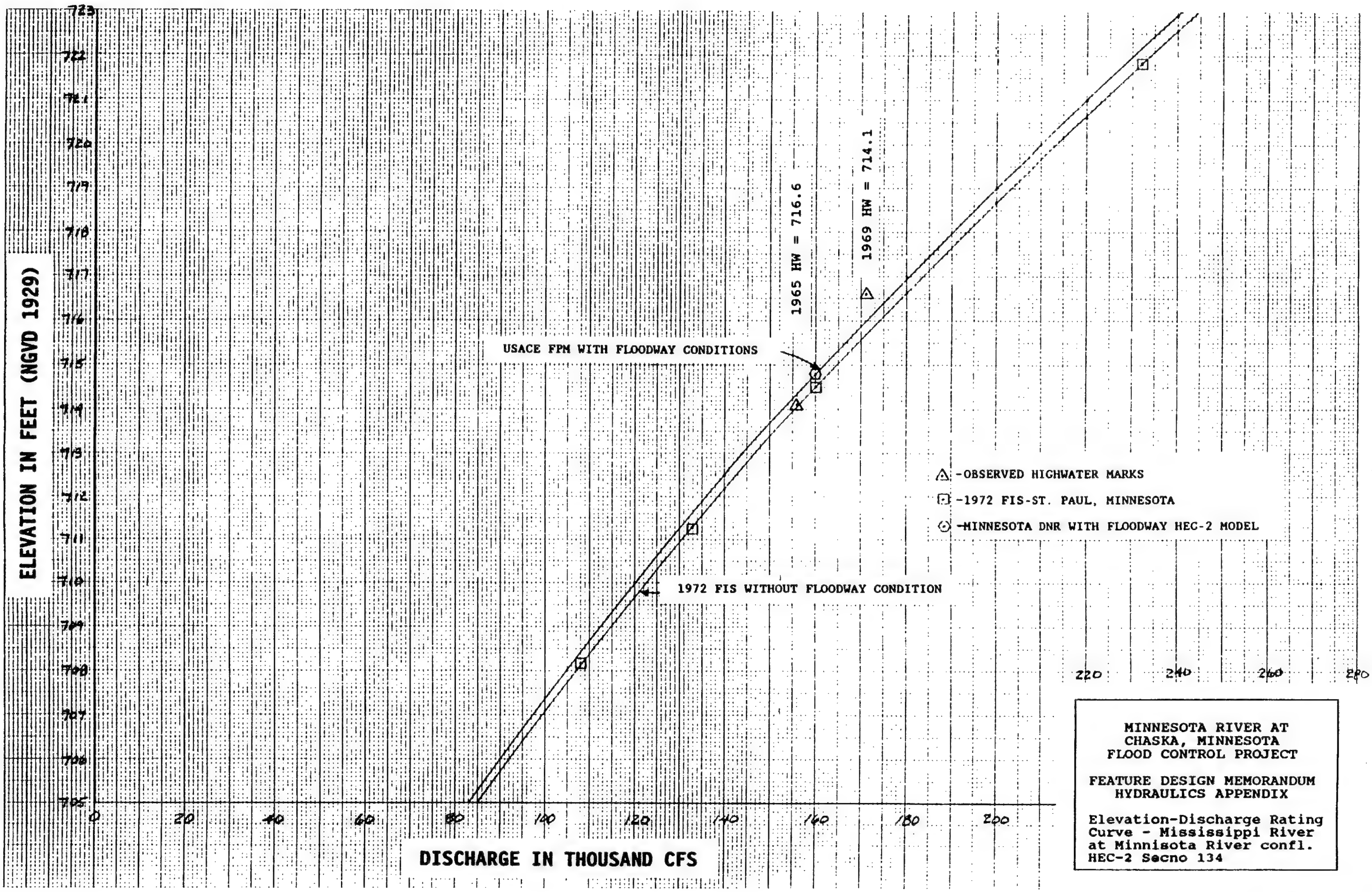
30.00
RIVER CHANNEL MILEAGE

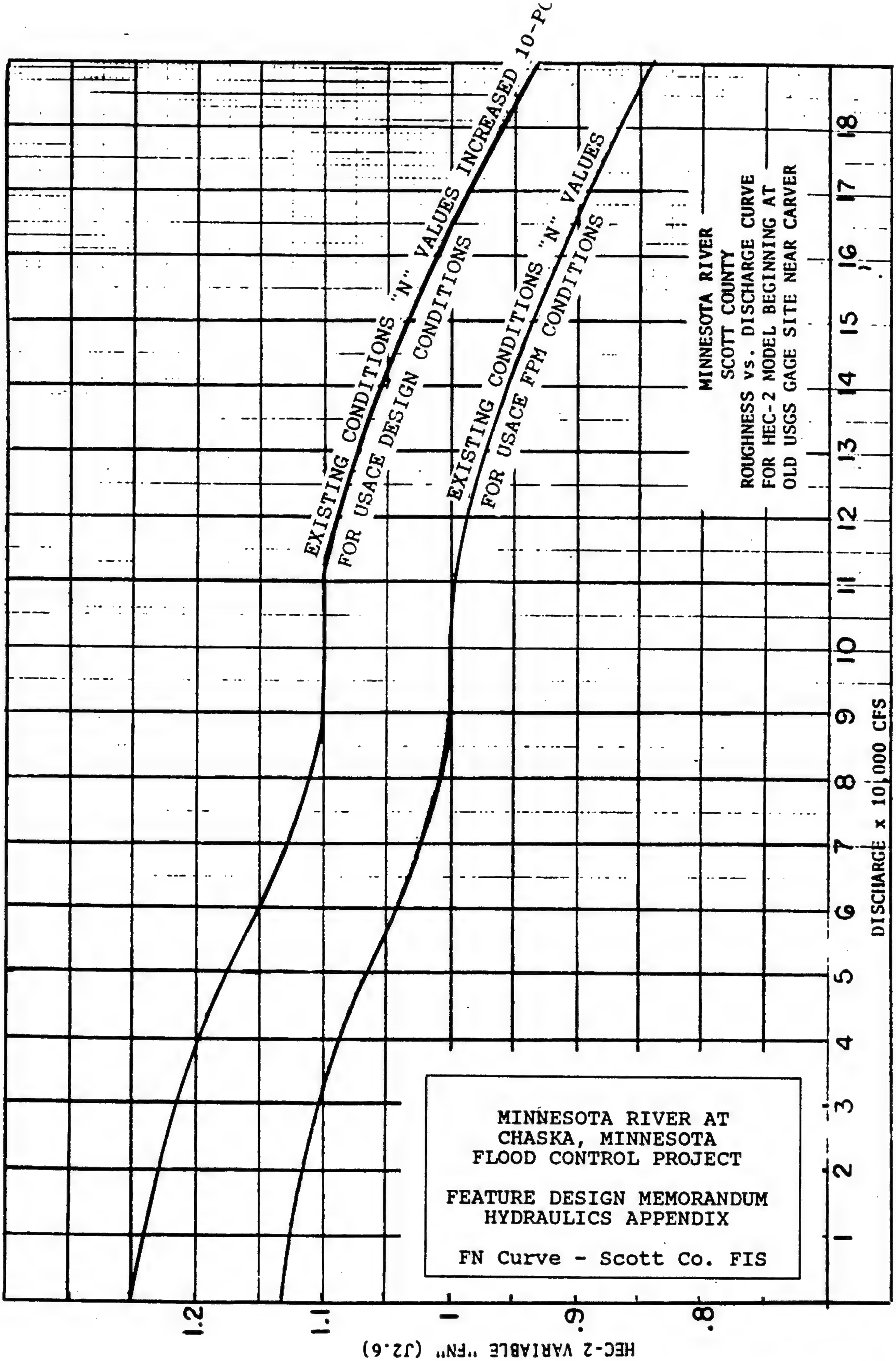


MINNESOTA RIVER AT
CHASKA, MINNESOTA
FLOOD CONTROL PROJECT

FEATURE DESIGN MEMORANDUM
HYDRAULICS APPENDIX

Elevation-Discharge Rating
Curve - Mississippi River
at Minnisota River confl.
HEC-2 Secno 134

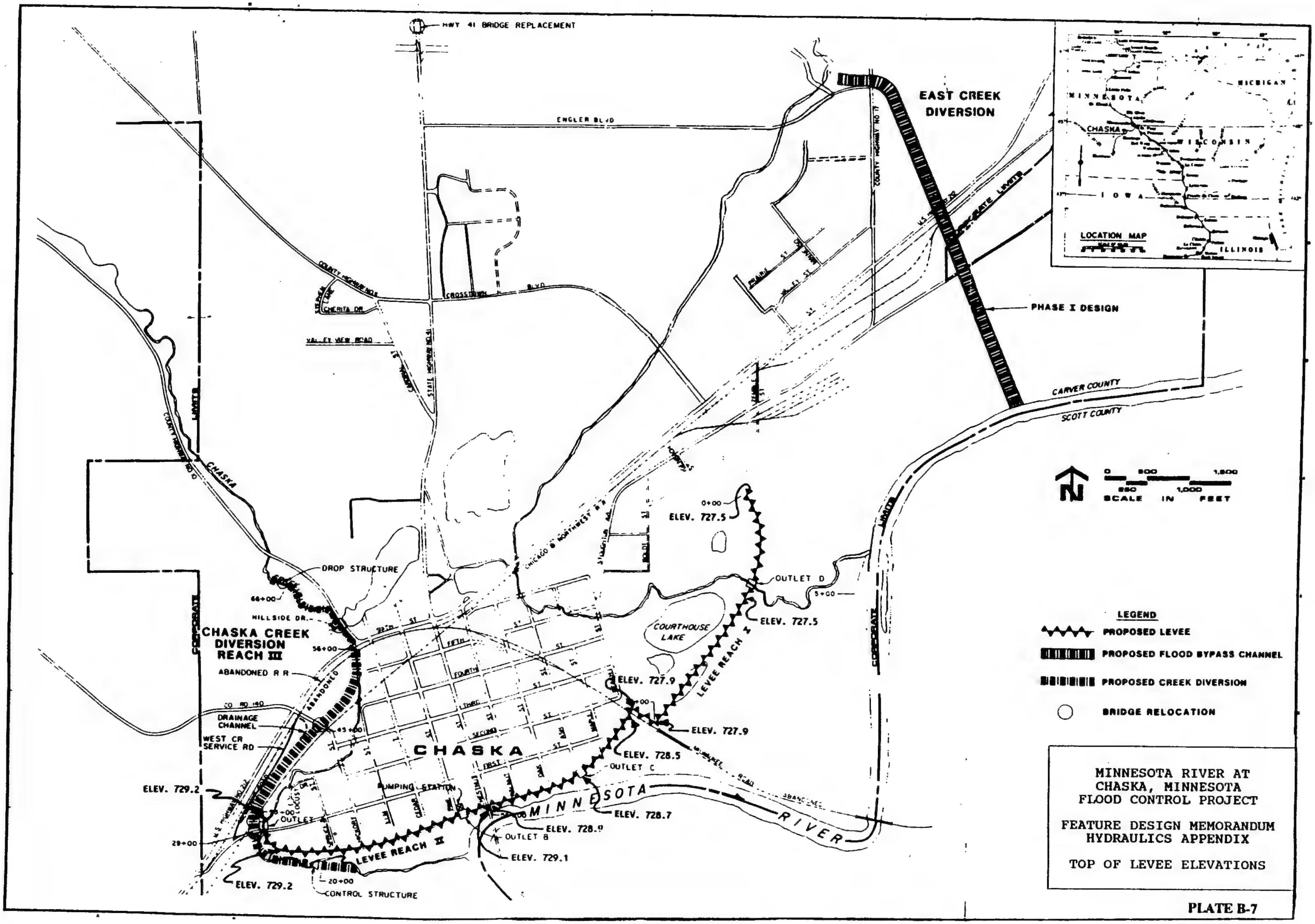
PLATE B-5



MINNESOTA RIVER AT
CHASKA, MINNESOTA
FLOOD CONTROL PROJECT

FEATURE DESIGN MEMORANDUM
HYDRAULICS APPENDIX

FN Curve - Scott Co. FIS



MINNESOTA RIVER AT CHASKA, MINNESOTA FLOOD CONTROL PROJECT

FEATURE DESIGN MEMORANDUM HYDRAULICS APPENDIX

TOP OF LEVEE ELEVATIONS

PLATE B-7

LEVEE OPENING AT EAST CREEK

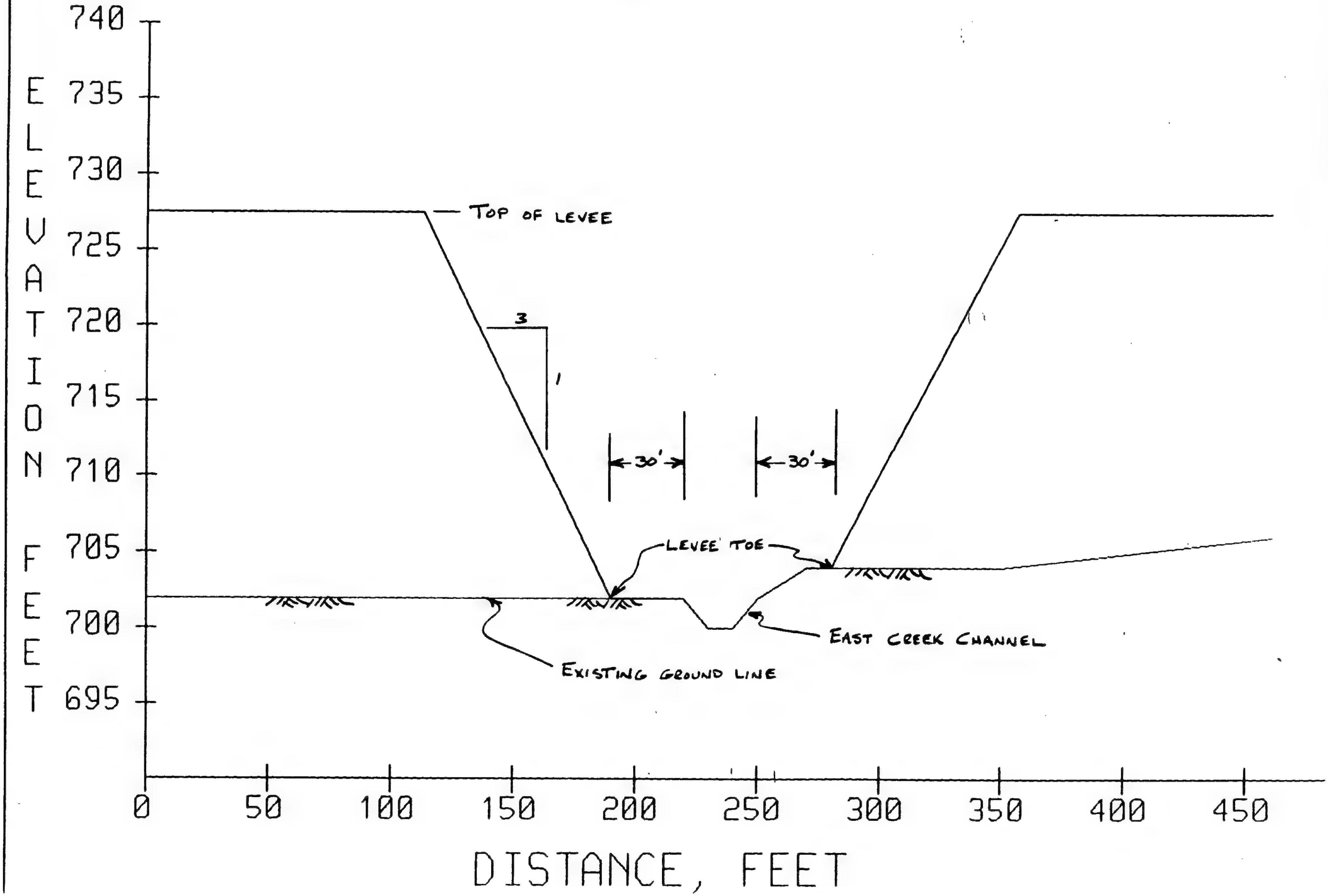


PLATE B-8

APPENDIX C

GEOTECHNICAL DESIGN

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX C

GEOTECHNICAL DESIGN

TABLE OF CONTENTS

ITEM	Page No.	Paragraph No.
TOPOGRAPHY	C-1	1
GEOLOGY	C-1	3
SUBSURFACE INVESTIGATIONS	C-1	4
SUBSURFACE PROFILES	C-2	7
PROJECT FEATURES	C-3	14
SLOPE STABILITY	C-5	20
SETTLEMENT	C-8	26
SEEPAGE AND UPLIFT	C-9	29
SOURCE OF CONSTRUCTION MATERIALS	C-10	36
CONSTRUCTIBILITY	C-11	40
FURTHER INVESTIGATIONS AND/OR ANALYSES	C-12	46

TABLES

Table 1	Seepage Quantities	C-13
Table 2	Summary of Seepage Calculations	C-14

PLATES

C-1	Boring Locations For Borings Not Shown Elsewhere
C-2	Boring Logs 73-1M thru 73-3M
C-3	Boring Logs 73-5M thru 73-9M & 73-10M
C-4	Boring Logs 73-11M thru 73-16M
C-5	Boring Logs 79-17M thru 79-22M
C-6	Boring Logs 80-23M thru 80-27M & 82-41M
C-7	Boring Logs 82-51M & 83-53M thru 83-55M
C-8	Boring Logs 83-58M thru 83-63M
C-9	Boring Logs 87-72M & 87-75M thru 87-77M
C-10	Boring Logs 88-102M, 88-103M, 89-106M & 89-110M
C-11	Boring Logs 89-111M thru 89-114M
C-12	Boring Logs 89-115M thru 89-118M
C-13	Boring Logs 89-119M & 89-121M thru 89-123M
C-14	Boring Logs 89-124M thru 89-126M & 89-130M
C-15	Main Channel Plan & Profile,Stage 2,(M34-CH-P-60/4)
C-16	Main Channel Plan & Profile,Stage 2,(M34-CH-P-60/5)
C-17	Levee Plan & Profile,Stage 2,(M34-CH-P-60/6)
C-18	Levee Plan & Profile,Stage 2,(M34-CH-P-60/7)
C-19	Boring Logs 73-4M thru 80-29M,Stage 2,(M34-CH-P-10/4)
C-20	Boring Logs 82-37M thru 82-50M,Stage 2,(M34-CH-P-10/5)
C-21	Boring Logs 83-52M thru 83-57M,Stage 2,(M34-CH-P-10/6)
C-22	Boring Logs 84-64M thru 84-71M,Stage 2,(M34-CH-P-10/7)
C-23	Boring Logs 85-81M thru 85-88M,Stage 2,(M34-CH-P-10/8)
C-24	Boring Logs 87-73M,87-74M,87-80M,87-81M,87-82A,87-84A,89-104M & 89-105M,Stage 2,(M34-CH-P-10/9)
C-25	Exist. Levee,Plots From Q-test From Remolded Sample and Unconfined Compression Test
C-26	Exist. Levee,Plots From Q-tests
C-27	Exist. Levee,Plots From R-tests
C-28	Exist. Levee,Plots From Rbar or S-tests
C-29	East of Courthouse Lake,Plots From Q-tests,CH,SPT<=4
C-30	East of Courthouse Lake,Plots From R-tests,CH,SPT<=4
C-31	East of Courthouse Lake,Plots From Rbar-tests,CH,SPT<=4
C-32	East of Courthouse Lake,Plots From R-tests,CH,SPT<=4(Revised)
C-33	East of Courthouse Lake,Plots From Rbar-tests,CH,SPT<=4(Revised)
C-34 thru C-35	Slope Stability Results(End of First Stage of Construction)
C-36 thru C-40	Slope Stability Results(End of Construction)
C-41 thru C-42	Slope Stability Results(Intermediate River Stage)
C-43 thru C-44	Slope Stability Results(Steady Seepage)
C-45 thru C-47	Slope Stability Input for Computer Runs
C-48 thru C-54	Typical Seepage Calculations

LABORATORY TESTING

FIGURES	DESCRIPTIONS	BORINGS
C-1 through C-16	Atterberg Limits and Gradations	73-1M through 73-8M
C-17 through C-26	Atterberg Limits and Gradations	79-11M thru 83-63M
C-27 through C-34	Atterberg Limits and Gradations	88-100M thru 89-130M
C-35	Atterberg Limits and Gradations	88-113M thru 89-124M
C-36 through C-38	Strength Tests	80-24MU
C-39 through C-42	Strength Tests	80-26MU
C-43 through C-73	Consolidation and Strength Tests	82-41MU
C-74 through C-82	Consolidation and Strength Tests	82-51MU
C-83 through C-99	Consolidation and Strength Tests	83-53MU
C-100 through C-103	Consolidation and Strength Tests	83-54MU
C-104 through C-111	Strength Tests	83-55MU
C-112 through C-117	Strength Tests	83-58MU
C-118 through C-120	Strength Tests	83-59MU
C-121 through C-123	Strength Tests	83-60MU
C-124 through C-131	Strength Tests	83-61MU
C-132 through C-145	Consolidation and Strength Tests	83-62MU
C-146 through C-160	Consolidation and Strength Tests	83-63MU
C-161 through C-189	Att.,Grad.,Consol.,& Strength Tests	87-72MU
C-190 through C-199	Att.,Grad.,Consol.,& Strength-Tests	87-75MU
C-200 through C-204	Gradations	87-76M
C-205 through C-222	Att.,Grad.,Consol.,& Strength Tests	87-77MU
C-223 through C-251	Consolidation and Strength Tests	88-102MU
C-252 through C-275	Consolidation and Strength Tests	88-103MU
C-276 through C-311	Consolidation and Strength Tests	89-7MU
C-312 through C-335	Consolidation and Strength Tests	89-106MU
C-336 through C-358	Consolidation and Strength Tests	89-110MU
C-359 through C-397	Consolidation and Strength Tests	89-112MU
C-398 through C-404	Strength Tests	89-117MU
C-405 through C-464	Consolidation and Strength Tests	89-119MU
C-465 through C-488	Consolidation and Strength Tests	89-126MU
C-489 through C-548	Consolidation and Strength Tests	89-130MU

TOPOGRAPHY

1. The portion of the city of Chaska, Minnesota, where the proposed flood control improvements would be located is within the Minnesota River Valley. The valley trends northeast and is approximately 2.5 miles wide in this reach. The floodplain lies at an approximate elevation of 705, averages 1 mile in width, and is characterized by extensive marshy areas and lakes. Alluvial and bedrock terraces rise above the floodplain and form regionally prominent benches at elevations of 750 and 800. Most of the developed portion of Chaska is situated between elevations of 710 and 730, at the upstream limit of a terrace that trends northeast along the base of the valley wall. The river valley walls rise sharply above the floodplain and terraces to form a bluff that grades into a hummocky, poorly-drained regional highland at an elevation of 850 on the north side of the valley, and at an elevation of 900 on the south side of the valley.

2. Chaska Creek emerges from the regional highland in a deep, steep-walled valley on the northwest side of Chaska and flows in a shallow channel around the western and southern edges of the city to the Minnesota River. East Creek emerges from a similar but smaller valley onto a large terrace about 1.5 miles northeast of Chaska. The creek flows southwesterly across the terrace, cuts through the northeast corner of Chaska, and joins the Minnesota River downstream of the city. The normal flow in the two creeks is sustained by groundwater discharging from pervious materials in thick deposits of glacial till that comprise the surrounding regional highlands.

GEOLOGY

3. The region surrounding the project area was glaciated extensively during the Pleistocene Epoch. Advancing and reteating glaciers laid down thick deposits of unsorted till and outwash sand that today form a hummocky, poorly-drained plain dotted with numerous marshes and small lakes. The glacial drift reaches a thickness of between 200 and 250 feet and lies unconformably on dolomitic limestone and sandstone of the Prairie du Chien and Jordan Formations. The large valley of the present Minnesota River was carved by the glacial River Warren, which carried large volumes of water discharging from the now-extinct glacial Lake Agassiz located in western Minnesota and eastern North Dakota. Glacial River Warren cut deeply into bedrock and formed the terraces that are prominent today. As the flows decreased, the valley was filled to its present level with alluvium. Recent borings and historic water well records indicate alluvium approximately 180 feet in thickness. Bedrock elevation is between 530 and 542(NGVD Adj.). The upper bedrock consists of weathered to slightly weathered fine grained,silty,glauconitic sandstone of the Franconia Formation.

SUBSURFACE INVESTIGATIONS

4. Borings have been taken and laboratory tests have been performed periodically from 1973 to 1989 as the study progressed to the present phase.

5. The 1973 borings were taken to determine the general characteristics of the soils along the entire reach of the project. The 1979 borings were taken to better define the soil profile used for uplift and seepage design along the levee. The 1980 borings were taken to determine soil types used in the existing levees. The 1982 borings were taken east of Courthouse Lake to obtain more information along the proposed levee alignment and to determine the material used to fill the area north of the sewage treatment plant. The 1983 borings were taken to obtain additional subsurface information all along the proposed levee alignment. The 1987 borings were taken to evaluate a VE proposal which would have rerouted Chaska Creek through a conduit under Elm Street. The 1988 borings were taken along one of the proposed alignments of East Chaska Creek. The 1989 borings were taken to better define the characteristics of the pervious zone underlying the site from the sewage treatment plant to Pine Street and to obtain more information on the low area east of Courthouse Lake.

6. Laboratory soil tests performed to date include water content, gradation tests, Atterberg limits , strength and consolidation. The laboratory test data are presented on figures C-1 to C-548.

SUBSURFACE PROFILES

7. The project site can be divided into five reaches that have fairly distinct soil profiles. The following table gives the reach number and stationing associated with that particular reach:

Reach No.	Stationing		
1	0+00	to	7+50
2	7+50	to	21+00
3	21+00	to	34+00
4	34+00	to	59+50
5	59+50	to	the upstream end of the project

8. In Reach 1 the levee foundation consists of firm to stiff silts and clays. There is also a shallow layer of poorly-graded gravel.

9. In Reach 2 the levee foundation consists of highly plastic soft clays overlying much firmer silts and clays. The soft materials have a maximum thickness of about twenty-five feet. The levee alignment in this reach runs near Courthouse Lake, which is an old open pit clay mine that has been filled with water to make a suitable habitat for trout. The bottom of Courthouse Lake is below elevation 650 and the lake bed has a steep slope in this area. Borings taken through the existing levee adjacent to the lake show considerable consolidation of the soft material.

10. Reach 3 is very similar to Reach 2 except that a large amount of uncontrolled fill has been placed northeast of the sewage treatment plant.

11. Borings taken by the county indicate that the area northwest of the sewage treatment plant was used in the past as a landfill.

12. In Reach 4 the boring logs show a deep sand foundation containing thin

impervious layers at various elevations throughout the reach. The sand foundation is generally composed of SP-SM type soils and is overlain by a relatively thin semipervious blanket. From the sewage treatment plant to Pine Street the depth of the pervious material encountered before a continuous cutoff is reached varies considerably. Some borings in this area show intermediate cutoffs at fairly shallow depths. It was reported that the existing levee between stations 35+00 and 41+00 was constructed with a flatter riverward slope than the rest of the levee because debris encountered during construction indicated some of the area may have been used as a landfill.

13. Reach 5 has a levee foundation consisting of a relatively thin semipervious top blanket over a relatively thin pervious zone that extends down to about elevation 686. This overlays a relatively thick layer of impervious clays,silts,and silty sands.

PROJECT FEATURES

14. The typical levee section will have 1V to 3H side slopes and a top width of 10 feet. Fill for the levee will be impervious. A bituminous walking trail on an aggregate base will be located on top of the levee. Erosion protection will generally consist of top soil and seeding. The riverward slope of the levee along the Minnesota River will be riprapped. Where required, an inspection trench with a 6 foot bottom width and side slopes no steeper than 1V to 1H will be excavated. Minimum trench depth will be 6 feet for levee heights equal or greater than 6 feet. For levee heights less than 6 feet, the minimum trench depth will be equal to the levee height.The trench will be backfilled with impervious material.

15. From station 0+00 to 7+50 a typical levee section will be used. Erosion protection will consist of top soil and seeding. An inspection trench will be located at the levee centerline.

16. From station 7+50 to 21+00 thirty foot wide berms will be provided on both the river side and land side of the typical levee section. Erosion protection will consist of top soil and seeding. Because of the low strength of the foundation materials the levee will be constructed in two stages. Since the foundation soils consolidate very slowly, "wick" drains will be installed under the levee prism to obtain the required consolidation for second-stage construction in a reasonable time period. A working pad of not less than 2 feet of pervious material will be placed to improve access for construction and to provide a horizontal drainage path for the flow from the "wick" drains. Soil strip drains will be provided along the top of each row of "wick" drains to provide additional horizontal drainage. The berms, which will be constructed of impervious material, are required to provide an adequate surcharge to consolidate the foundation material under the edge of the levee prism and develop sufficient foundation strength for second-stage construction. In order to prevent the pervious working pad from becoming a seepage path through the levee, the riverside berm will be placed on the natural subgrade. First-stage construction will raise the levee to elevation 717. The primary fill(first-stage fill) will need to remain in place for 220 to 330 days before the berms are cut to final grade final and the second-stage fill placed. Second-stage construction will raise the levee to

its final height. During the second stage of the construction the berms may be cut to elevation 708. An overbuild of 1 foot will be required on this section of the levee because of anticipated second-stage settlement. An inspection trench will not be required in this reach. Since the design of the East Creek outfall has not been completed an opening will be left in the levee between stations 8+60 and 10+60. The proposed location of the outfall is north of the current creek location and the existing creek will be moved south to allow room to place a surcharge on the proposed outfall location. The surcharge will consolidate the foundation soils at the outfall location. "Wick" drains and the pervious fill working pad should be placed in the East Creek levee opening so the area is ready for fill placement when the outfall is constructed.

17. From station 21+00 to station 34+00 the levee construction will be similar to Reach 2 except that the new section will blanket an existing fill and a land side berm will not be placed. From station 21+00 to station 28+00 the existing uncontrolled fill will be thickly blanketed with impervious fill to provide an acceptable levee. From station 28+00 to station 34+00 the material used in the existing fill appears suitable for levee construction and the thickness of the new "blanketing" fill is reduced. "Wick" drains will be placed from the toe of the existing fill slope to the riverward toe of the new levee. Strip drains which penetrate the impervious riverside berm every 20 feet will provide horizontal drainage for the "wick" drains. These strip drains will be removed after construction. An inspection trench will not be required for this reach. Erosion protection will be provided with top soil and seeding. An existing access road crosses the levee at station 34+00.

18. From station 34+00 to 59+50 the typical levee section will generally be used. From station 36+00 to 43+00 a levee section similar to Reach 3 will be used because of the possibility of soft material existing under the new fill being placed riverward of the existing levee. Relief wells will be required at the landside levee toe from approximately station 36+00 to 59+50. A manhole will be located at each relief well to provide access for maintenance. Flow from the relief wells will be collected by an interceptor pipe running parallel to the levee. A pump station will be located at station 48+00. The depths of the wells will vary depending on the depth of the pervious layer underlying the levee. A 17' wide berm of semipervious material will be placed at the landside toe of the levee. This berm intersects the levee slope at elevation 713. This berm provides frost protection for the relief wells. An inspection trench will run along the landside toe of the levee. Riprap will be placed on the riverside slope of the levee from station 44+50 to 58+00. From station 44+50 to 51+90 the riprap will extend from the riverbed to elevation 710 to protect the levee from being undermined by erosion from the river. From station 51+90 to 58+00 the riprap will extend from the riverbottom to the top of the levee to protect the levee from both undermining and from higher velocities at, and in the near vicinity of, the Highway 41 bridge. Erosion protection for the rest of this reach will be provided by top soil and seeding. Low areas along the land side of the levee from station 36+00 to the upstream end of the project will be filled. Fill elevations in the low areas will be 710 from station 36+00 to 39+50, 708 from station 39+50 to 48+00, 709 from station 48+00 to 59+00, and 710 from station 59+00 to the upstream end of the project. All existing sewer lines crossing the levee will be removed and the excavations backfilled with impervious

material. Pipes that run parallel to the alignment and that are buried in the levee and/or berm prism will be either removed or grouted full length, depending on their location and depth. Interior drainage will flow from the surface through inlets to the interceptor. The inlets are surrounded with pervious material to prevent problems with uplift. The outlets for the interceptor under gravity flow conditions are located at stations 48+00 and 55+90. An existing ditch on the riverside of the levee at station 41+50 will be filled with impervious material to an elevation of 705. Where fill is required on the river side of the levee impervious material will be used above elevation 705 and either random or pervious material will be used below 705. Pervious fill will be required when fill is placed under water.

19. From station 59+50 to 71+20 a typical levee section with a 75 foot wide land side berm will be constructed. From station 71+20 to 76+50 a 75 foot wide berm will be placed on the land side of the levee constructed during Stage 2 of this project. The 75 foot wide berm will intersect the levee at elevation 713.5. The berm will be constructed with semipervious material. Erosion protection will be provided by topsoil and seeding. Where the existing levee is moved riverward(from station 59+50 to 70+00) the existing levee will be removed down to the elevation 710. The existing levee material will be used in the new levee construction. One relief well is provided at the beginning of the reach. Surface drainage and flow from the relief well are handled in the same way as in Reach 4. An access road crosses the levee at station 62+30. Existing utility lines in the levee will be removed and relocated outside the levee and berm prisms. Ditches on the riverside of the levee at stations 67+20 and 73+00 will be filled with impervious material to an elevation of 705. An inspection trench will run on the landside toe of the levee from station 59+50 to station 60+00. The inspection trench moves from the landside toe of the levee to the riverside toe of the levee between stations 60+00 and 64+00. The inspection trench will run along the riverside toe of the levee from station 64+00 to tie in to the inspection trench installed during stage 2 construction. Low areas along the land side of the levee will be filled to a minimum elevation of 710.

SLOPE STABILITY

20. The side slopes on the existing levees are, in general, too steep to meet current stability criteria. To improve both stability and maintainability levee slopes will be 1V to 3H.

21. Criteria used for the slope stability analysis are from EM 1110-2-1913 and EM 1110-2-1902. Computations were made using the computer programs UTEXAS2 and I0013. UTEXAS2 was used to analyze the end of construction and steady seepage cases while I0013 was used to analyze the intermediate river stage case. Stability analyses were performed for a typical levee section east of Courthouse Lake, at the East Creek levee opening(parallel to the levee alignment), at station 15+50 where the new levee is adjacent to the existing embankment around Courthouse Lake, and at station 53+60. The sudden drawdown case was not analyzed since the Minnesota River characteristically drops from flood stage very slowly.

22. The soil strengths used in the stability analyses at station 15+50, for

the typical section east of Courthouse Lake, and at the East Creek levee opening are given below:

Soil Type	Soil Description	Q phi	Q c(psf)	R phi	R c(psf)	S phi	S c(psf)
1	soft foundation soils	0	300	14	100	24	0
2	firm foundation soils and existing embankment	0	1200	18	600	27	0
3	impervious levee fill	0	1200	18	600	27	0
5	consolidated soft foundation soils	0	550				
6	consolidated soft foundation soils	0	720				

The soil strength parameters for the impervious levee fill, the firm foundation soils, and the existing embankment were assumed to be equal to the strength of CL soils in the area that have SPT results of 4 to 14 blows per foot. The firm foundation soils are actually much stronger than this. Strengths for soil types 5 and 6(the soft foundation soils consolidated under the first-stage loading) were determined at normal stresses of 1800 psf and 2500 psf respectively. Samples of impervious levee fill from the proposed borrow area have not been tested at this time but will be tested to verify the strength values prior to completion of the plans and specifications. Plates C-29 to C-31 show the data from the soft foundation soils strength tests. A review of the strengths showed higher values(see Plates C-32 and C-33) could have been used. Calculations will be redone using the higher strengths for the soft foundation soils once soils strengths for the borrow material are obtained.

23. The soil strengths used in the analysis at station 53+50 are as follows:

Soil Type	Soil Description	Q phi	Q c(psf)	R phi	R c(psf)	S phi	S c(psf)
1	upper sand foundation	33	0	33	0	33	0
2	top blanket(SM)	30	0	30	0	30	0
3	exist. levee	0	1200	18	600	27	0
4	pervious fill	30	0	30	0	30	0
5	impervious fill	0	1200	18	600	27	0
6	lower sand foundation	33	0	33	0	33	0
7	riprap	36	0	36	0	36	0

SPT results from the borings were used to judge soil parameters for the upper and lower foundation sand. Parameters for the riprap were assumed. In addition the end of construction cases were generally run using non-linear shear strength envelopes for both the impervious fill and the existing levee. This results in lower strengths being used than those shown above and results in lower factors of safety than would be obtained if the shear strengths shown on plates C-25 thru C-28 were used for the existing levee.

24. The results of the slope stability analyses are given below. The sections analyzed and the critical surfaces obtained are shown on plates C-34

through C-44.

Stability Case	Factor of Safety Required*	Computed
I. End of first stage of construction		
Parallel to levee at East Creek opening		1.02
Typical section east of Courthouse Lake		1.01
II. End of Construction		
Parallel to levee at East Creek opening		1.50
Typical section east of Courthouse Lake	1.3	1.36
Station 15+50	1.3	1.51
Station 53+60	1.3	1.64
III. End of Construction (landside w/ high water)		
Typical section east of Courthouse Lake	1.3	1.46
IV. Sudden Drawdown	1.0	NA
V. Intermediate River Stage		
Typical section east of Courthouse Lake	1.4	1.46
Station 53+60	1.4	1.42
VI. Steady Seepage from Full Flood Stage		
Typical section east of Courthouse Lake	1.4	1.41
Station 53+60	1.4	1.47

*As stated in EM 1110-2-1913

25. Several alternative methods of constructing the levee from station 7+50 to 31+00 were considered and are described below.

a. Single-stage construction with excavation and replacement of the soft foundation soils. This would require excavation to elevation 685 under the levee prism and stability berms about 9 feet high and 100 feet wide on each side of the levee.

b. Single-stage construction with sand piles installed through the soft foundation soils. With no stability berm, this would require 2-foot diameter sand piles spaced 3 feet center to center.

c. Two-stage construction with sand drains installed through the foundation soils. This would require 2-foot diameter sand drains spaced at 10 feet center to center and stability berms about 6 feet high and 30 feet wide.

d. Two-stage construction with "wick" drains installed through the soft foundation soils. This method requires 30-foot wide stability berms and "wick" drains spaced at 5 feet center to center.

The two-stage "wick" drain method of construction was considered the best

alternative.

SETTLEMENT

26. The CSETT (I0019) computer program along with several 20/20 spreadsheet computations were used to determine the settlement between stations 7+50 and 31+00. CSETT was used to evaluate the time rate of settlement without "wick" drains under the embankment. Methodology from "Designing With Geotextiles" by Robert M. Koerner was used to determine the time rate of settlement when using the "wick" drains. CSETT was used to determine settlement after the first stage of construction and total settlement. A total settlement of 3.5 feet will occur at the centerline of the levee. The majority of this settlement(2.7 feet) will result from the first stage loading. A 1' overbuild will be required on this portion of the levee. The following table shows settlement of the levee from station 7+50 to 21+50. Settlement of the riverward portion of the levee from station 21+50 to 31+00 will be similar.

Distance from centerline(feet)	0	20	40	60	80	100	120
Stage 1 settlement(feet)	2.73	2.73	2.72	2.68	2.24	1.21	0.11
Total settlement(feet)	3.56	3.26	*	*	*	*	*
Difference	0.83	0.53					

*Note: At distances of 40 feet or more from the centerline, excavation of the berms for Stage 2 construction results in an unloading of the soft foundation soils. Consequently, the total settlement at these locations will be what occurs under the Stage 1 loading.

27. The centerline of the levee from the sewage treatment plant upstream to about station 42+00 has been moved considerably riverward of the centerline of the existing levee. The riverward shift of the levee in combination with the higher levee and the 1V to 3H riverward slope results in a significant portion of the new levee being placed on potentially soft foundation soils riverward of the existing levee. "Wick" drains and a berm are presently shown along the riverside of the levee in this area. During the plans and specifications phase the levee will either be moved landward to minimize fill placement on the riverward side of the existing levee or borings will be taken riverward of the existing levee to confirm the need for the berms and "wick" drains.

28. Because of the riverward shift in the levee alignment between stations 60+00 and 70+00, borings, testing, and settlement analyses will be required along the new levee alignment to determine the amount of overbuild required. The new borings will also allow verification of foundation conditions for seepage, uplift, and slope stability.

SEEPAGE AND UPLIFT

29. Due to the nature of the foundation materials there will be minimal seepage from station 0+00 to 34+50.

30. The borings taken along the levee alignment upstream of station 34+50 show foundation conditions typical of those that cause seepage and uplift problems during a flood. These foundation conditions include deep layers of relatively clean sands and(upstream of about station 60+00) a layered foundation of relatively clean sands, silts, and clays. High rates of seepage, small sand boils, and "quick" or "near-quick" conditions have been reported landward of the levee during past floods. Records indicate that approximately 20,000 gpm were pumped during the peak of the 1969 flood, which crested at 720.3. However, this figure includes sanitary wastewater, groundwater infiltration to the sanitary system ,and other interior runoff. Based on precipitation records at Minneapolis,Minnesota, the limited reevaluation report roughly estimated between 5000 and 10000 gpm of underseepage.

31. Criteria used in the analysis are from EM 1110-2-1913 which require a minimum factor of safety of 1.5 against uplift and a maximum allowable upward gradient of 0.5 at the levee toe. Computer programs used in the analyses were LEVEEMSU and 20/20 spreadsheets. Permeabilities for the pervious layer under the levee are based on D_{10} sizes and Figure 3-5 in EM 1110-2-1913. Although three other methods(a method from "Construction Dewatering" by J. Patrick Powers, Hazen's equation, and the Mash and Denny relationship from EM 1110-2-1901) were used to determine the horizontal permeabilities of the pervious layers for comparison purposes, the method from EM 1110-2-1913 was generally used for design. In general all these methods except the one from "Construction Dewatering" were developed for SP or SW type soils and the majority of the soils in the pervious layers are SP-SM soils. The permeability of the riverside blanket materials were obtained from Table C-1 in EM 1110-2-1913 and the permeabilities of the landside top stratum were obtained from Table 38 in TM 3-424. Relief wells were designed using computer program I0015. Relief wells were designed to provide a factor of safety against uplift of 1.7 at the midpoint location between relief wells. The percent penetration of the well screen in the transformed foundation was determined in accordance with the method shown on page 293 of TM 3-424 (same as using equations 9-24 to 9-29 in EM 1110-2-1901). EM 1110-2-1901 recommends oversizing the well screen and gravel pack area to allow for clogging. The current design is based on a 33% decrease in the well screen and gravel pack area before well maintenance is required.

32. Seepage and uplift calculations were generally made at each boring along the levee alignment. The seepage quantities were calculated using a water surface elevation 3 feet below the top of the levee. Uplift pressures were calculated using the water surface at the top of the levee. A summary of seepage quantities is shown in Table 1. A summary of seepage and uplift calculations is shown in Table 2. The exit gradients were greater than 0.5 from station 78+00 to 84+00 when using permeabilities from the D_{10} size and figure 3-5 of EM 1110-2-1913. Using permeabilities from Hazen's equation the exit gradient from station 78+00 to 81+00 was below 0.5 but the exit gradient from 81+00 to 84+00 was still greater than 0.5. An exit gradient(I1 in Table

2) was determined for the top stratum of the top blanket and this gradient was below 0.5.

33. In general the land surface rises with increasing distances from the river. The analysis method contained in the EM assumed a flat grade either side of the levee. LEVEEMSU was used to check the adequacy of the design where there was both a landside and riverside top blanket. It was assumed that the aquifer is generally unconfined when the ground surface rises beyond the landside levee toe and that the phreatic surface landward of the levee toe is generally equal to the minimum landside ground surface. The LEVEEMSU results were consistent with those obtained using the EM 1110-2-1913 methodology. A slightly higher gradient was obtained between station 34+50 and 36+30 because LEVEEMSU was able to model a partial seepage block.

34. Since the calculations were completed, the levee centerline between Pine Street and Hickory Street has been moved riverward.An additional well was added north of Pine Street to reduce the berm width in that area. Although it is not anticipated that these changes will materially affect the seepage quantities or uplift pressures, the calculations have not been revised due to time constraints. The calculations will be checked during the plans and specifications phase.

35. There is a good possibility that the depths of the wells may be reduced during construction if shallower continuous impervious layers are found in the pervious aquifer when the pilot borings are made for each well. One area where this may occur is along the levee between Maple and Ash Streets. If the intermediate cutoff layer is found to be continuous between three to four-hundred feet of well screen could be saved.

SOURCE OF CONSTRUCTION MATERIALS

36. Impervious fill will be obtained from an existing borrow area just west of Chaska on County Highway 10. The city has an agreement with the borrow area owner to purchase material from this site. Sampling and testing of the material will be performed during preparation of the plans and specifications for the project.

37. Granular fill of adequate quality is available within 10 miles of Chaska. Pervious fill is defined as material with 100% passing the number 4 sieve and less than 5% passing the number 200 sieve. Semi-pervious fill is defined as 100% passing the number 4 sieve and from 5% to 12% passing the number 200 sieve. Either semi-pervious or pervious material shall be used to construct the landside berms upstream of station 34+50.

38. Riprap and bedding of adequate quality can be obtained from existing quarries located within 40 miles of Chaska. The construction contractor for the Stage 2 work obtained riprap from a quarry in New Ulm, Mn., which is 65 miles from Chaska.

39. Concrete aggregate of adequate quality can be obtained from continuously operating natural aggregate and crushed rock sources in the Minneapolis-St.

Paul ,Minnesota, metropolitan area. The distance from the project to reliable sources in this area would be 25 to 50 miles. Closer sources located within 10 miles of Chaska exist but produce concrete aggregate on an intermittent basis. Although only one of these sources has been tested for Corps of Engineers projects, information obtained from the Minnesota Department of Transportation indicates most of these sources would be adequate for concrete aggregate.

CONSTRUCTIBILITY

40. Between stations 7+50 and 31+00 instrumentation will be required to monitor both stages of levee construction over the soft foundation soils. The design, location, and monitoring plan for the instrumentation will be developed during the plans and specifications phase. It is anticipated that instrumentation for the soft foundation soils will include piezometers, settlement plates, and slope indicators at selected locations. The specifications need to contain language that allows Government control of fill placement rates and of the period of time between the completion of fill placement for Stage 1 and the commencement of fill placement for Stage 2. The two foot thick pervious fill construction pad and the "wick" drains should be installed in the levee opening for East Creek to avoid a future mobilization for these operations.

41. Any excess impervious fill removed from the levee section(berm) between stations 7+50 and 34+00 shall be stockpiled for future use. The excess material could be used to fill the opening in the levee at East Creek or possibly for Stage 3 construction.

42. The city of Chaska has requested removal of the existing levee between the County Courthouse and Courthouse Lake. If classification tests confirm that the existing levee material is impervious the material could be used in the new levee construction. Removal of the existing levee would have to be timed so that the existing flood protection at Chaska is not significantly reduced.

43. Each relief well will require a pilot boring. Samples must be taken at appropriate depth intervals(5 feet or at every change in soil type) so soil permeabilities can be checked(using the D_{10} methodology) to insure design conditions are applicable and to insure proper installation of the wells. The depth of the pertinent aquifer also needs to be verified. The final well spacing may vary from design spacing. Pump tests of selected wells will be required to check design permeability.

44. During installation of the interceptor piping care must be taken to insure that the integrity of the top blanket is restored.

45. Existing sewer lines crossing the levee will be removed. To insure through seepage will not be a problem the excavations will be backfilled with impervious materials even though in most cases the sewer lines are below the top blanket material. The existing sewer lines on the riverside of the levee will be filled full length with grout.

FURTHER INVESTIGATIONS AND/OR ANALYSES

46. The items listed below which will require further investigations/analyses to complete before the plans and specifications.

a. The borrow area for impervious fill must be located, sampled and tested.

b. Slope stability analyses need to be checked once strength tests are obtained for the impervious borrow material. At the same time, the revised strengths shown on Plates C-32 and C-33 will be used where appropriate.

c. If the levee alignment between stations 31+00 and 42+00 is not moved landward, additional borings and testing will be required to verify the need for the "wick" drains and the berm on the riverward side of the levee and to evaluate settlement of the 24 inch ductile iron pipe that crosses the levee at about station 32+00.

d. Seepage, stability, and settlement/overbuild need to be reevaluated between stations 59+50 and 70+00, where the levee alignment has been shifted about 70 feet riverward of the existing alignment. Two new borings are recommended along the riverward toe of the new levee to determine foundation conditions in this reach. Depending on the subsurface conditions shown by the new borings, additional sampling and testing of the foundation soils may also be required.

e. Design instrumentation and monitoring plan for staged construction over the soft foundation soils from station 7+50 to station 31+00.

f. Design the well screen and the gravel pack gradation for the relief wells.

g. Select the bedding gradation and the filter fabric for the riprap.

h. Determine if the existing levee on the west side of Courthouse Lake contains material suitable for use in constructing the new levee. If so, determine acceptable timing for removal of the existing levee.

TABLE NO. 1

Seepage Quantities for Chaska,Stage 4

Section Number	applied between station	Reach Length (ft)	Seepage Quantities exist. unit gpm/ft	total gpm	design unit gpm/ft	total gpm	well flow unit gpm/ft	total gpm
	0 + 0							
0		3450	0	0	0	0	0	0
	34+ 50							
1		80	0.766	61.28	0.766	61.28		0
	35+ 30							
2		370	2.043	755.91	0.195	72.15	2.55	943.5
	39+ 0							
3		480	2.009	964.32	0.372	178.56	2.237	1073.76
	43+ 80							
4		480	3.354	1609.92	0.305	146.4	4.609	2212.32
	48+ 60							
5		320	3.33	1065.6	0.417	133.44	4.866	1557.12
	51+ 80							
6 upper		430	1.667	716.81	0.2	86	2.182	938.26
6 lower		430	2.073	891.39	2.073	891.39		0
	56+ 10							
7 upper		330	0.824	271.92	0.137	45.21	1.04	343.2
7 lower		330	2.846	939.18	2.846	939.18		0
	59+ 40							
8-well		160	0.284	45.44	0.14	22.4	0.168	26.88
	61+ 0							
8		180	0.284	51.12	0.284	51.12		0
	62+ 80							
9		420	0.222	93.24	0.222	93.24		0
	67+ 0							
10		850	0.346	294.1	0.342	290.7		0
	75+ 50							
11**		325	0.14	45.5	0.14	45.5		0
	78+ 0							
12		300	0.381	114.3	0.381	114.3		0
	81+ 0							
13		300	0.627	188.1	0.627	188.1		0
	84+ 0							
14		775	0.243	188.325	0.243	188.325		0
	91+ 75							
				8296.46		3547.3		7095.04 *1.33= 9436.4

grand total======= 12983.7

notes:

1. The above assumes an intermediate cutoff at elev. 664 between Walnut and Pine streets which limit pressures to those in the top portion of the aquifer.
2. Well flow is increased by 1.33% to comply with the EM 1110-2-1901 requirement that relief wells be designed with a factor of safety against clogging.
3. Finished grade landside minimum elevation @ 710 from 36+00-39+50
4. Finished grade landside minimum elevation @ 708 from 39+50-48+00
5. Finished grade landside minimum elevation @ 709 from 48+00-59+00
6. Finished grade landside minimum elevation @ 710 from 59+00-91+75
7. 8" wells,riser @ 706, 59' deep,102'o.c.,35+81-39+89
8. 8" wells,riser @ 706, 59' deep, 72'o.c.,40+61-44+21
9. 8" wells,riser @ 706, 60' deep, 46'o.c.,44+67-48+35
10. 8" wells,riser @ 706, 48' deep, 67'o.c.,49+02-51+70
11. 8" wells,riser @ 706, 39' deep, 74'o.c.,52+44-55+80
12. 8" wells,riser @ 706, 38' deep, 80'o.c.,55+80-59+40
13. 8" wells,riser @ 706, 10' deep,60+30

**-note the change in stationing,77+00=76+25 GDM stationing

TABLE NO. 2				
Reach	34+50 to 35+30	35+30 to 39+00	39+00 to 43+80	43+80 to 48+60
Section	1	2	3	4
top of levee	728.7	728.7	728.7	728.9
top blanket material	SP,SC,SM	SM	SM	SM
top blanket elevation	710.5	710	708	708
bottom blanket elevation	701	707.2	705	705.7
bottom aquifer	626.2	626.2	626.6	634.2
L1	200	200	200	NA
L2	119.2	122.2	134.2	135.4
L3	1000	1000	1000	1000
Zt	8.2	2.8	3	2.3
Zbl	3.9	2.8	3	2.3
Kbl	0.0008	0.002	0.002	0.002
Zbr	3.7	2.8	3	NA
Kbr	0.00016	0.0014	0.0014	NA
Df	74.8	81	78.8	71.5
Kf	0.105	0.069	0.061	0.088
head used for uplift design	18.2	18.7	20.7	20.9
head used for seepage design	15.2	15.7	17.7	17.9
X3	195.7	88.5	84.9	85.1
X1	851	110.6	97.6	.43Df
shape factor "S"	0.06416	0.2521	0.24879	0.28462
uplift head at levee toe	3.1	5.1	5.5	7.1
resisting wgt. at levee toe	515.8	175.3	187.8	144
F.S. at levee toe against uplift	2.71	0.55	0.54	0.33
Qs	0.766	2.043	2.009	3.354
Io	0.37	1.84	1.85	3.08
I1				

Berm info								
Xsp			112.9		109.8		198.2	
thickness at levee toe			3.5		3.8		6.2	
Xp			72.8		70.4		114.9	
thickness at levee toe			2.1		2.3		3.6	
Qp,flow per foot of levee(gpm)			1.36		1.32		2.9	
Xs			99.5		96.7		170.5	
thickness at levee toe			2.7		2.9		4.6	
XI			417.5		415.6		715.4	
thickness at levee toe			7.2		8		10.4	
well info								
top of riser elevation			706		706		706	
l.s.water			710		708		708	
spacing			102		72		46	
% penetration			80		80		80	
hw			-3.795		-1.895		-1.839	
hav1			4.651		3.12		2.718	
TM			0.792		0.724		0.632	
TAV			0.676		0.616		0.537	
h,mid1			1.6541		1.77201		1.35984	
Quew			2.55		2.237		4.609	
Qsw			0.195		0.372		0.305	
Qtotal			2.745		2.609		4.914	
Boring	79-12M		89-122M		89-125M		89-123M	
section	1		2		3		4	
notes:								

Notes:
1. Terms shown above are from EM 1110-2-1913(Appendices B and C) or WES program I0015(Design For Infinite Series Of Relief Wells).
2. "I1" is the exit gradient of the top stratum of the top blanket.
3. "h,mid1" is the head at the landside toe of the levee at the midpoint distance between relief wells.
4. For typical seepage calculation see PLATES C-48 through C-54.

TABLE NO. 2 (continued)

Reach	48+60 to 51+80		51+80 to 56+10			56+10 to 59+40	
Section	5		6	6		7	7
top of levee	728.9		729.2	729.2		729.2	729.2
top blanket material	SM		SM	SM		SM,CL	SM,CL
top blanket elevation	709.5		709.5	709.5		709	709
bottom blanket elevation	706.2		706	663.3		705	664
bottom aquifer	613		664.6	564.7		665.2	576
L1	NA		NA	NA		25	25
L2	126.4		128.2	128.2		131.2	131.2
L3	1000		1000	1000		1000	1000
Zt	3.3		3.5	46.2		4	45
Zbl	3.3		3.5	4.4		3.4	9.5
Kbl	0.002		0.002	0.001		0.0008	0.0008
Zbr	NA		NA	NA		3.1	7.8
Kbr	NA		NA	NA		0.00016	0.00016
Df	93.2		41.4	98.6		39.8	88
Kf	0.081		0.07	0.057		0.038	0.133
head used for uplift design	19.4		19.7	19.7		20.2	20.2
head used for seepage design	16.4		16.7	16.7		17.2	17.2
X3	111.607		71.2	169.3		80.2	372.8
X1	.43Df		.43Df	.43Df		24.8	25
shape factor "S"	0.33515		0.19059	0.29111		0.1685	0.16635
uplift head at levee toe	7.8		6.5	9.8		6.9	14.2
resisting wgt. at levee toe	206.6		219.1	2883.5		250.4	2817
F.S. at levee toe against uplift	0.43		0.54	4.69		0.59	3.17
Qs	3.33		1.667	2.073		0.824	2.846
Io	2.36		1.85	0.21		1.71	0.32
I1							

Berm info							
Xsp	184.6		88.4			88.2	
thickness at levee toe	5.7		4.3			4.3	
Xp	120.9		60			61.6	
thickness at levee toe	3.6		2.7			2.8	
Qp,flow per foot of levee(gpm)	2.61		1.12			0.52	
Xs	163.4		79			79.3	
thickness at levee toe	4.4		3.3			3.3	
XI	542		283.7			270.1	
thickness at levee toe	8.8		7.7			7.5	
well info							
top of riser elevation	706		706			706	
l.s.water	709.5		709.5			709	
spacing	67		74			80	
% penetration	70		90			98	
hw	-3.203		-3.364			-2.94	
hav1	4.554		4.477			4.37	
TM	0.794		0.658			0.622	
TAV	0.702		0.543			0.512	
h,mid1	1.94782		2.06117			2.36887	
Quew	4.866		2.182			1.04	
Qsw	0.417		0.2			0.137	
Qtotal	5.283		2.382			1.17	
Boring	89-124M		89-118M			73-1M	
section	5		6	6		7	7
notes:							

Notes:
1. Terms shown above are from EM 1110-2-1913(Appendices B and C) or WES program I0015(Design For Infinite Series Of Relief Wells).
2. "I1" is the exit gradient of the top stratum of the top blanket.
3. "h,mid1" is the head at the landside toe of the levee at the midpoint distance between relief wells.
4. The first column in section 6 is the analysis of the upper aquifer at that section. The second second column in section 6 is the analysis for the deeper aquifer at that section.
5. The first column in section 7 is the analysis of the upper aquifer at that section. The second second column in section 7 is the analysis for the deeper aquifer at that section.
6. For typical seepage calculation see PLATES C-48 through C-54.

TABLE NO. 2 (continued)

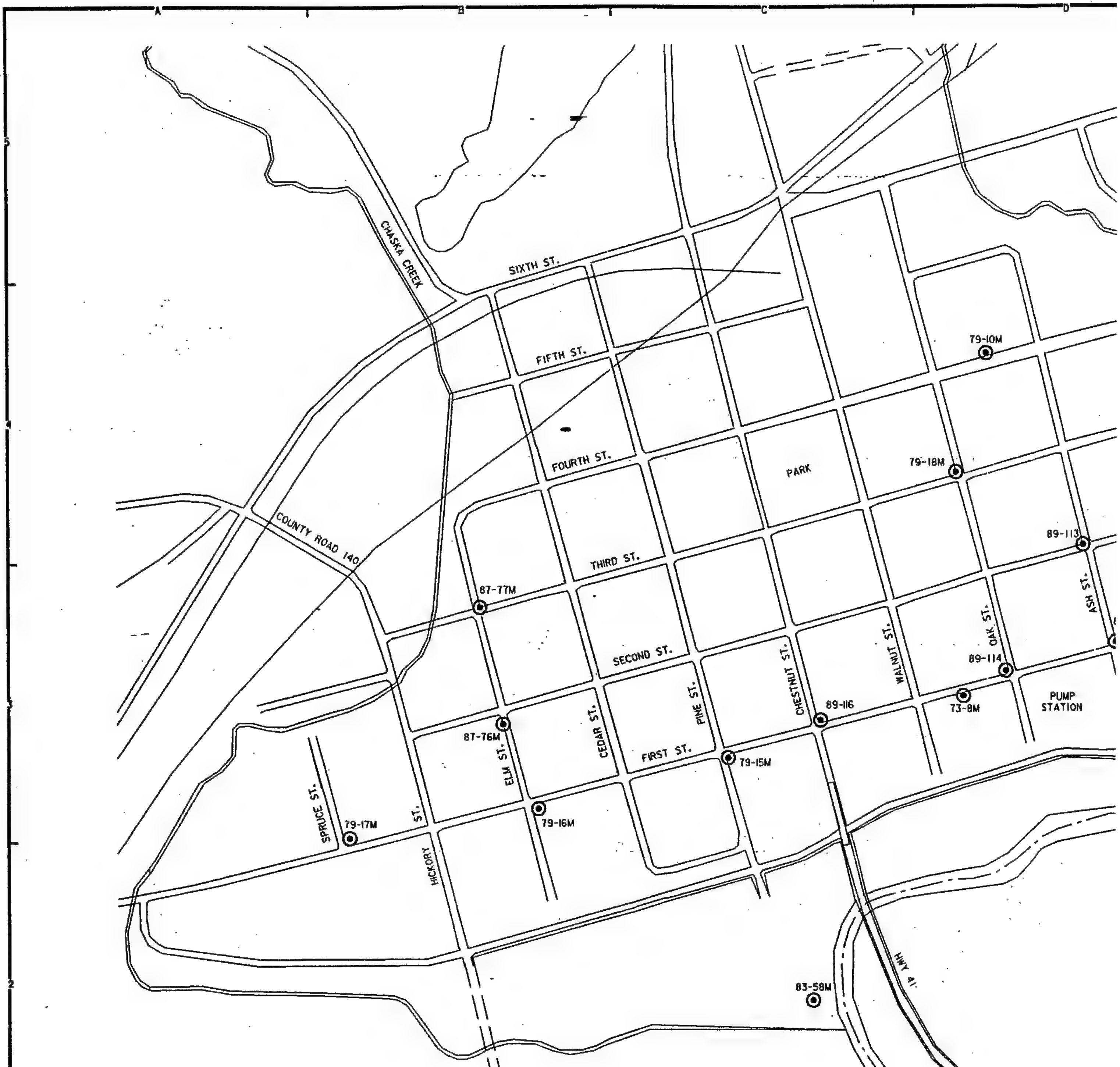
Reach	59+40 to 62+80		62+80 to 67+00		67+00 to 75+50	
Section	8	8	9	9	10	10
top of levee	729.2	729.2	729.2	729.2	729.2	729.2
top blanket material	CL	SM,CL	GC,SM	SM,GC,SM	SM,SC,CL	SM,SC,CL
top blanket elevation	710	713	710	713	710	713
bottom blanket elevation	705	705	704	704	705	705
bottom aquifer	693.7	693.7	688	688	688	688
L1	300	300	250	250	250	250
L2	125.2	107.2	125.2	107.2	125.2	107.2
L3	1000	1000	1000	1000	1000	1000
Zt	5.5	8	6	8	5	8
Zbl	5.5	6.3	5	6.5	4.1	5.3
Kbl	0.0006	0.0006	0.001	0.001	0.0008	0.0008
Zbr	5.5	5.7	4.6	5.4	3.7	4
Kbr	0.0001	0.0001	0.0004	0.0004	0.00016	0.00016
Df	11.3	11.3	16	16	17	17
Kf	0.087	0.087	0.028	0.028	0.056	0.056
head used for uplift design	19.2	16.2	19.2	16.2	19.2	16.2
head used for seepage design	16.2	13.2	16.2	13.2	16.2	13.2
X3	94.9	101.6	47.3	54	69.8	79.4
X1	199.8	201.9	71.6	77.5	138.5	142.7
shape factor "S"	0.02691	0.02751	0.06553	0.06704	0.05097	0.05163
uplift head at levee toe	4.3	4	3.7	3.7	4	3.9
resisting wgt. at levee toe	343.8	500	332.5	505	305	477.5
F.S. at levee toe against uplift	1.27	2	1.43	2.21	1.22	1.96
Qs	0.284	0.236	0.222	0.185	0.346	0.285
Io	0.79	0.5	0.74	0.46	0.8	0.49
I1						

Berm info								
Xsp								
thickness at levee toe								
Xp								
thickness at levee toe								
Qp,flow per foot of levee(gpm)								
Xs								
thickness at levee toe								
XI								
thickness at levee toe								
well info								
top of riser elevation	706							
l.s.water	710							
spacing	320							
% penetration	96							
hw	-3.88							
hav1	6.185							
TM	0.871							
TAV	0.766							
h,mid1	3.15281							
Quew	0.168							
Qsw	0.14							
Qtotal	0.308							
Boring	89-121M			79-19M			80-23M	
section	8	8		9	9		10	10
notes:								

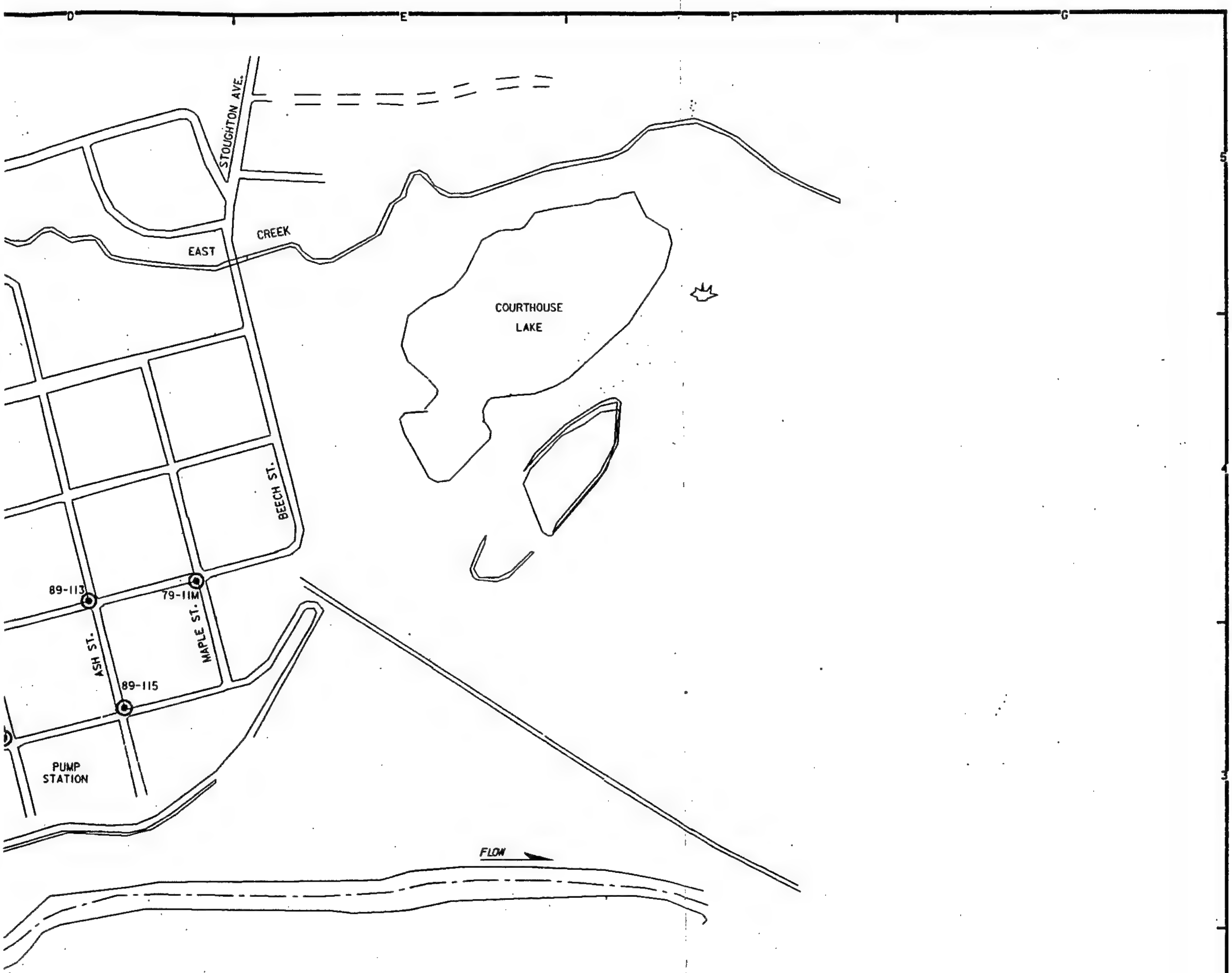
Notes:
1. Terms shown above are from EM 1110-2-1913(Appendices B and C) or WES program I0015(Design For Infinite Series Of Relief Wells).
2. "I1" is the exit gradient of the top stratum of the top blanket.
3. "h,mid1" is the head at the landside toe of the levee at the midpoint distance between relief wells.
4. The first column in section 8 is the analysis used for the design of the relief well at that section. The second column is the analysis at that section with a berm with a top elevation of 713.
5. The first column in section 9 is the analysis of the existing condition with the landside ground elevation of 710. The second column is the anlysis at that section with a berm with a top elevation of 713.
6. The first column in section 10 is the analysis of the existing condition with the landside ground elevation of 710. The second column is the anlysis at that section with a berm with a top elevation of 713.
7. For typical seepage calculation see PLATES C-48 through C-54.

TABLE NO. 2 (continued)

Reach	75+50 to 78+00	78+00 to81+00		81+00 to 84+00		84+00 to 91+75
Section	11	12	12	13	13	14
top of levee	729.2	729.2	729.2	729.2	729.2	729.2
top blanket material	CL,OL,CH SC,SP-SM	SC,SM,SC	SC,SM,SC	SM,ML,SP-SM	SM,ML,SP-SM	SM-ML,CL
top blanket elevation	710	715	715	719	719	720
bottom blanket elevation	696	705.3	705.3	709	709	707.5
bottom aquifer	686	685.3	685.3	693	693	675
L1	100	80	80	90	90	60
L2	125.2	95.2	95.2	71.2	71.2	65.2
L3	1000	1000	1000	1000	1000	1000
Zt	14	9.7	9.7	6.5	6.5	12.5
Zbl	10.7	7.8	7.8	4	4	8.3
Kbl	0.0006	0.0008	0.0008	0.001	0.001	0.0008
Zbr	10.5	7	7	2.7	2.7	6.7
Kbr	0.0001	0.00016	0.00016	0.0014	0.0014	0.00016
Df	10	15.4	15.4	16	16	27
Kf	0.034	0.084	0.036	0.19	0.077	0.046
head used for uplift design	19.2	14.2	14.2	10.2	10.2	9.2
head used for seepage design	16.2	11.2	11.2	7.2	7.2	6.2
X3	77.9	112.3	73.5	110.3	70.2	113.5
X1	91.6	77.1	73.6	79.8	68.9	58.7
shape factor "S"	0.03394	0.05411	0.06354	0.06125	0.07607	0.11375
uplift head at levee toe	5.1	5.6	4.3	4.3	3.4	4.4
resisting wgt. at levee toe	882.5	590.8	590.8	409.2	409.2	704.8
F.S. at levee toe against uplift	2.79	1.69	2.2	1.52	1.93	2.57
Qs	0.14	0.381	0.192	0.627	0.315	0.243
Io	0.36	0.58	0.44	0.66	0.52	0.35
I1				0.57	0.45	
Qtotal						
Boring	79-21M	83-55M		89-105M		82-37M
section	11	12	12	13	13	14
notes:	station change		Hazen's		Hazen's	



PLAN
BORING LOCATIONS
SCALE: 1" = 250'-0"



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

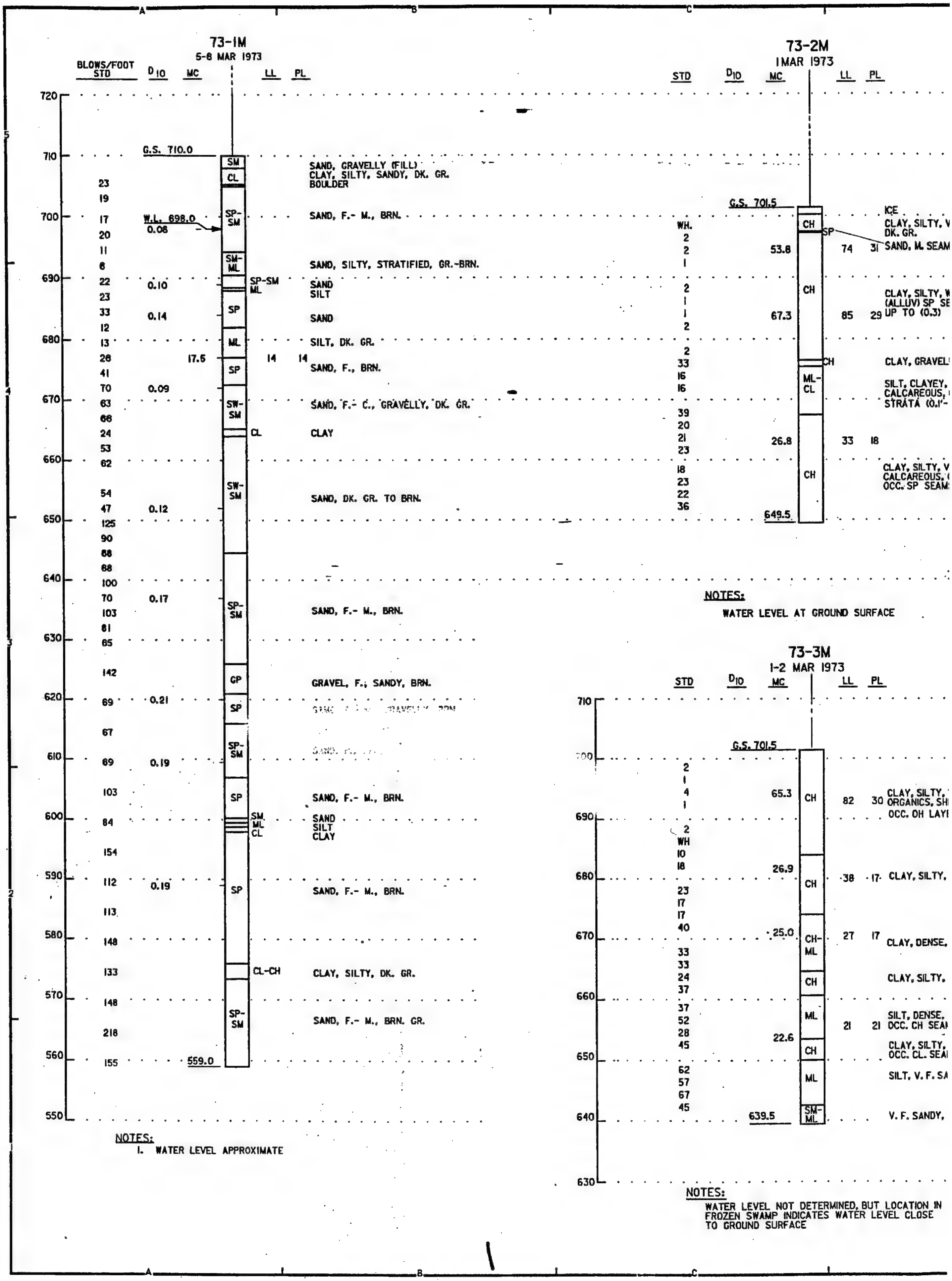
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA CREEK STAGE 4 CHASKA, MINNESOTA
BORING LOGS
BORING LOCATIONS
FOR BORINGS NOT SHOWN ELSEWHERE

ED-D	DESIGNED:
	CHECKED:
	DRAWN: LKT
ED-GH	DESIGNED: JRC
	CHECKED: JRC
DATE: 05-04-91	

CAD FILE NAME: NC05RMAP.DGN	DRAWING NUMBER:	SHT 1
SPEC NO: DACW37-90-B-0000	PLATE C-1	OF 14

2



73-1M
5-8 MAR 1973
BLOWS/FOOT STD
D10
MC
LL
PL
G.S. 710.0
W.L. 698.0
SAND, GRAVELLY (FILL)
CLAY, SILTY, SANDY, DK. GR.
BOULDER
SAND, F.- M., BRN.
SAND, SILTY, STRATIFIED, GR.-BRN.
SAND
SILT
SAND
SILT, DK. GR.
SAND, F., BRN.
SAND, F.- C., GRAVELLY, DK. GR.
CLAY
SAND, DK. GR. TO BRN.
SAND, F.- M., BRN.
GRAVEL, F., SANDY, BRN.
SAND, F.- M., BRN.
SAND
SILT
CLAY
SAND, F.- M., BRN.
CLAY, SILTY, DK. GR.
SAND, F.- M., BRN. GR.
559.0
NOTES:
1. WATER LEVEL APPROXIMATE
73-2M
1 MAR 1973
STD
D10
MC
LL
PL
G.S. 701.5
ICE
CLAY, SILTY, V
DK. GR.
SAND, M. SEAM
CLAY, SILTY, W
(ALLUV) SP SE
UP TO (0.3)
CLAY, GRAVEL
SILT, CLAYEY,
CALCAREOUS,
STRATA (0.1'-
CLAY, SILTY, V
CALCAREOUS,
OCC. SP SEAM
649.5
NOTES:
WATER LEVEL AT GROUND SURFACE
73-3M
1-2 MAR 1973
STD
D10
MC
LL
PL
G.S. 701.5
CLAY, SILTY,
ORGANICS, SH
OCC. OH LAY
CLAY, SILTY,
CLAY, DENSE,
CLAY, SILTY,
SILT, DENSE,
OCC. CH SEA
CLAY, SILTY,
OCC. CL. SEA
SILT, V. F. SA
V. F. SANDY,
639.5
NOTES:
WATER LEVEL NOT DETERMINED, BUT LOCATION IN FROZEN SWAMP INDICATES WATER LEVEL CLOSE TO GROUND SURFACE

720
710
Y, V. SOFT, ORGANIC, SHELLS. — 700
EAM (0.2)
690
Y, WET, SHELLS, DK. GR.
SEAMS (0.1') ORGANIC SEAMS
680
/ELLY, SANDY, BRN-GR.
EY, MED. DENSE, MOIST-WET.
IS, GR-BRN
.I'- 0.4') MI — 670
660
Y, V.STIFF, MOIST, LAM.,
IS, GR.
AMS (0.1'-0.3')
650
640

710
700
TY, WET, SHELLS, SL.
, SHELLS, DK. GR.
.AYERS (0.2') — 690
TY, STIFF, MOIST, MED. GR. — 680
670
ISE, V. STIFF, MOIST, DK. GR
TY, V. STIFF, MOIST, DK. GR.
660
SE, SAT., GR
SEAMS (0.2')
TY, V. STIFF, MOIST, DK. GR.
SEAMS (0.1') — 650
. SANDY, V. DENSE, SAT., GR.
DY, SILTY, DENSE, SAT., GR — 640
630
IN
E

GENERAL BORING LEGEND

84-IM	YEAR OF BORING-BORING NUMBER, BORING TYPE (EG: M=MACHINE, A=AUGER, TP=TEST PIT, P=PIEZOMETER).
IMAY 1984	DATE OF BORING
G.S. 1020.2	GROUND SURFACE ELEVATION AT BORING
GW	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURE, LITTLE OR NO FINES
GP	POORLY GRADED GRAVELS, LITTLE OR NO FINES
GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SM	SILTY SANDS, SAND - SILT MIXTURES
SC	CLAYEY SANDS, SAND - CLAY MIXTURES
ML	INORGANIC SILTS, LIQUID LIMIT LESS THAN 50
MH	INORGANIC SILTS, LIQUID LIMIT GREATER THAN 50
CL	INORGANIC CLAYS, LOW TO MEDIUM PLASTICITY, LIQUID LIMIT LESS THAN 50
CH	INORGANIC CLAYS, HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
OL	ORGANIC SILTS OR CLAYS, LOW PLASTICITY, LIQUID LIMIT LESS THAN 50
OH	ORGANIC SILTS OR CLAYS, MEDIUM TO HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
PT	PEAT
SP-SM	BORDERLINE MATERIAL
SP& SM	STRATIFIED MATERIAL
1	LOCATION AND SAMPLE NUMBER FOR UNDISTURBED SAMPLE
	NO RECOVERY
W.L. 726.7	WATER LEVEL ON DATE OF BORING
700	ELEVATION AT BOTTOM OF BORING

GENERAL BORING NOTES

1. GENERAL : THE UNIFIED SOIL CLASSIFICATION SYSTEM IS USED TO IDENTIFY BASIC SOIL TYPE. THE LEGEND REPRESENTS ONLY THE BASIC SOILS TO COMPLETE THE CLASSIFICATION, PERTINENT INFORMATION IS ADDED TO THE RIGHT OF THE BORING STAFF. NOTES PERTAINING TO A SPECIFIC BORING ARE SHOWN BELOW THE BORING STAFF.
2. MOISTURE CONTENT: THE NATURAL MOISTURE CONTENT IN PERCENT OF DRY WEIGHT (MC) IS SHOWN TO THE LEFT OF THE BORING LOG.
3. BLOW COUNT (SPT): BLOW COUNTS ARE SHOWN TO THE LEFT OF THE BORING STAFF AND, EXCEPT AS NOTED, ARE THE NUMBER OF BLOWS NECESSARY TO DRIVE THE SAMPLER USED A DISTANCE OF 12". STANDARD BLOW COUNTS ARE FOR A STANDARD PENETRATION TEST (SPT) USING A 1-3/8" X 2" SAMPLER, 140 LB HAMMER AND A 30" DROP. FOR NON-STANDARD BLOW COUNTS, SAMPLER SIZE, HAMMER WEIGHT AND HEIGHT OF DROP ARE AS SHOWN.
4. ATTERBERG LIMITS: LIQUID LIMIT (LL) AND PLASTIC LIMIT (PL) ARE SHOWN TO RIGHT OF THE BORING STAFF.
5. D_{10} SIZE: THE GRAIN SIZE IN MILLIMETERS OF WHICH 10% OF THE SAMPLE IS FINER IS SHOWN TO THE LEFT OF THE BORING STAFF.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

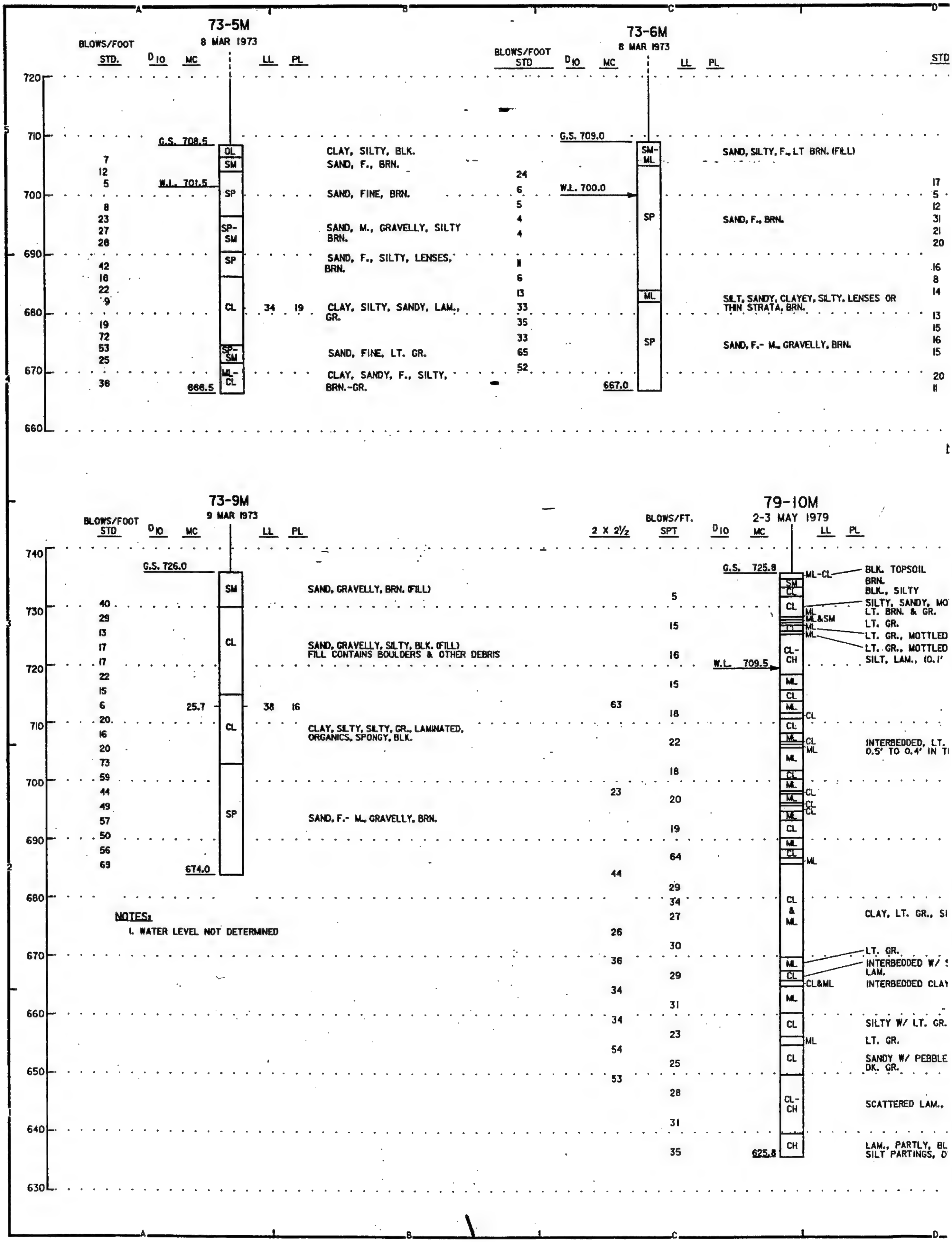
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA CREEK STAGE 4 — CHASKA, MINNESOTA
BORING LOGS
BORING LOGS 73-IM THRU 73-3M

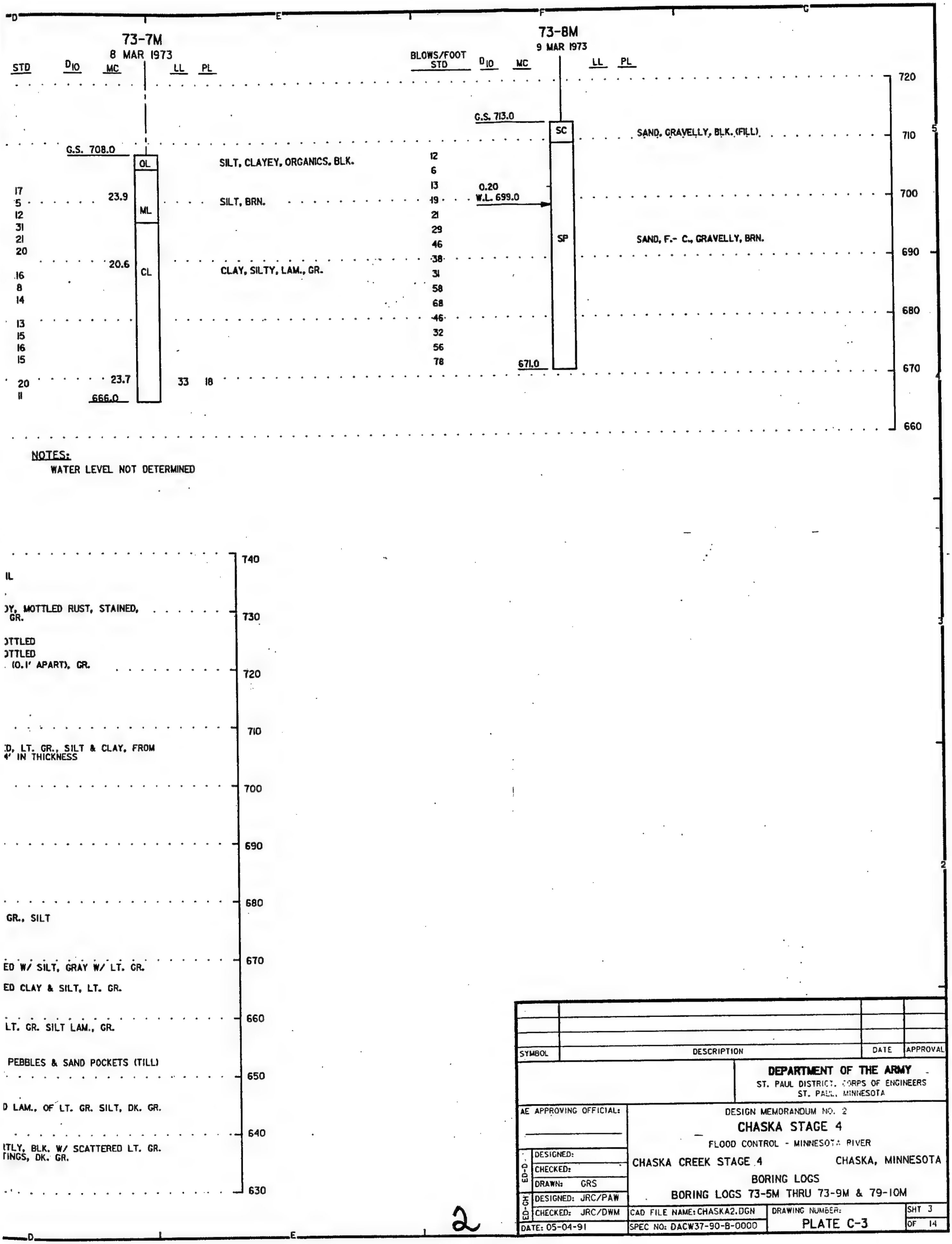
ED-D	DESIGNED:
	CHECKED:
	DRAWN: GRS
ED-GH	DESIGNED: JRC/PAW
	CHECKED: JRC/DWM
DATE: 05-04-91	

CAD FILE NAME: CHASKA1.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE C-2
SHT 2 OF 14

2



73-5M
8 MAR 1973
BLOWS/FOOT STD.
D10 MC LL PL
G.S. 708.5
W.L. 701.5
OL SM SP SP-SM SP CL SP-SM ML-CL
CLAY, SILTY, BLK.
SAND, F., BRN.
SAND, FINE, BRN.
SAND, M., GRAVELLY, SILTY BRN.
SAND, F., SILTY, LENSES, BRN.
CLAY, SILTY, SANDY, LAM., GR.
SAND, FINE, LT. GR.
CLAY, SANDY, F., SILTY, BRN.-GR.
666.5
73-6M
8 MAR 1973
BLOWS/FOOT STD
G.S. 709.0
W.L. 700.0
SM-ML SP ML SP
SAND, SILTY, F., LT BRN. (FILL)
SAND, F., BRN.
SILT, SANDY, CLAYEY, SILTY, LENSES OR THIN STRATA, BRN.
SAND, F.- M., GRAVELLY, BRN.
667.0
73-9M
9 MAR 1973
BLOWS/FOOT STD
G.S. 726.0
SM CL CL SP
SAND, GRAVELLY, BRN. (FILL)
SAND, GRAVELLY, SILTY, BLK. (FILL)
FILL CONTAINS BOULDERS & OTHER DEBRIS
CLAY, SILTY, SILTY, GR., LAMINATED, ORGANICS, SPONGY, BLK.
SAND, F.- M., GRAVELLY, BRN.
674.0
NOTES:
1. WATER LEVEL NOT DETERMINED
79-10M
2-3 MAY 1979
2 X 2½
BLOWS/FT. SPT
G.S. 725.8
W.L. 709.5
BLK. TOPSOIL
BRN.
BLK., SILTY
SILTY, SANDY, MO
LT. BRN. & GR.
LT. GR.
LT. GR., MOTTLED
LT. GR., MOTTLED
SILT, LAM., (0.1'
INTERBEDDED, LT.
0.5' TO 0.4' IN TI
CLAY, LT. GR., SI
LT. GR.
INTERBEDDED W/
LAM.
INTERBEDDED CLAY
SILTY W/ LT. GR.
LT. GR.
SANDY W/ PEBBLE
DK. GR.
SCATTERED LAM.,
LAM., PARTLY, BL
SILT PARTINGS, D
625.8



SYMBOL	DESCRIPTION	DATE	APPROVAL

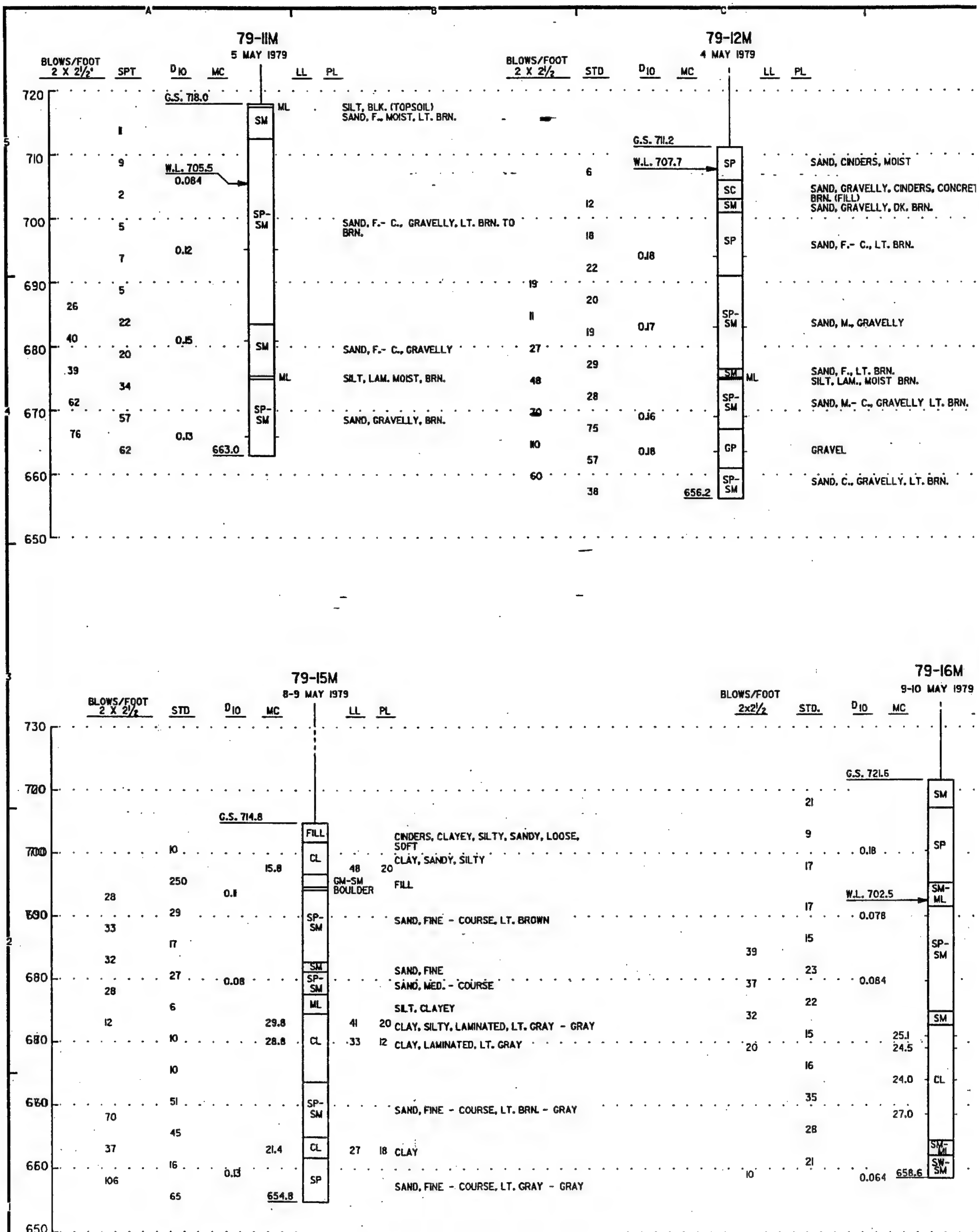
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA CREEK STAGE 4 CHASKA, MINNESOTA
BORING LOGS
BORING LOGS 73-5M THRU 73-9M & 79-10M

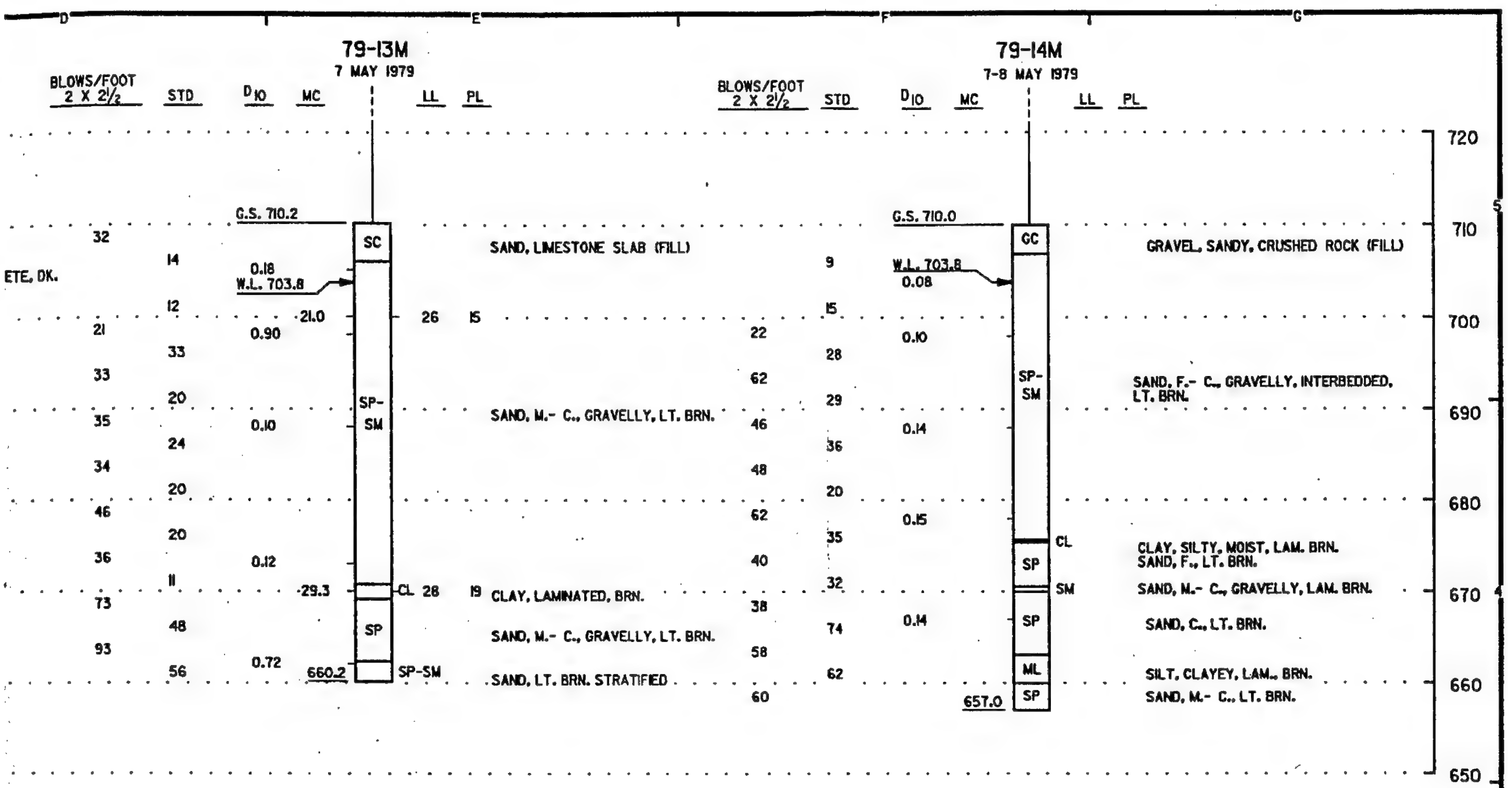
ED-D: DESIGNED: / CHECKED: / DRAWN: GRS
ED-GH: DESIGNED: JRC/PAW / CHECKED: JRC/DWM
DATE: 05-04-91
CAD FILE NAME: CHASKA2.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE C-3
SHT 3 OF 14

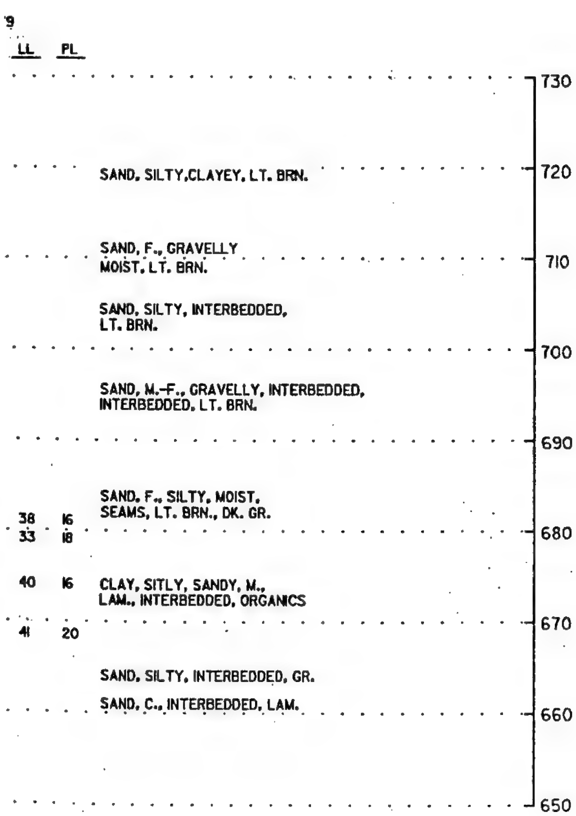
2



NOTES:

1. WATER LEVEL NOT DETERMINED





SYMBOL	DESCRIPTION	DATE	APPROVAL

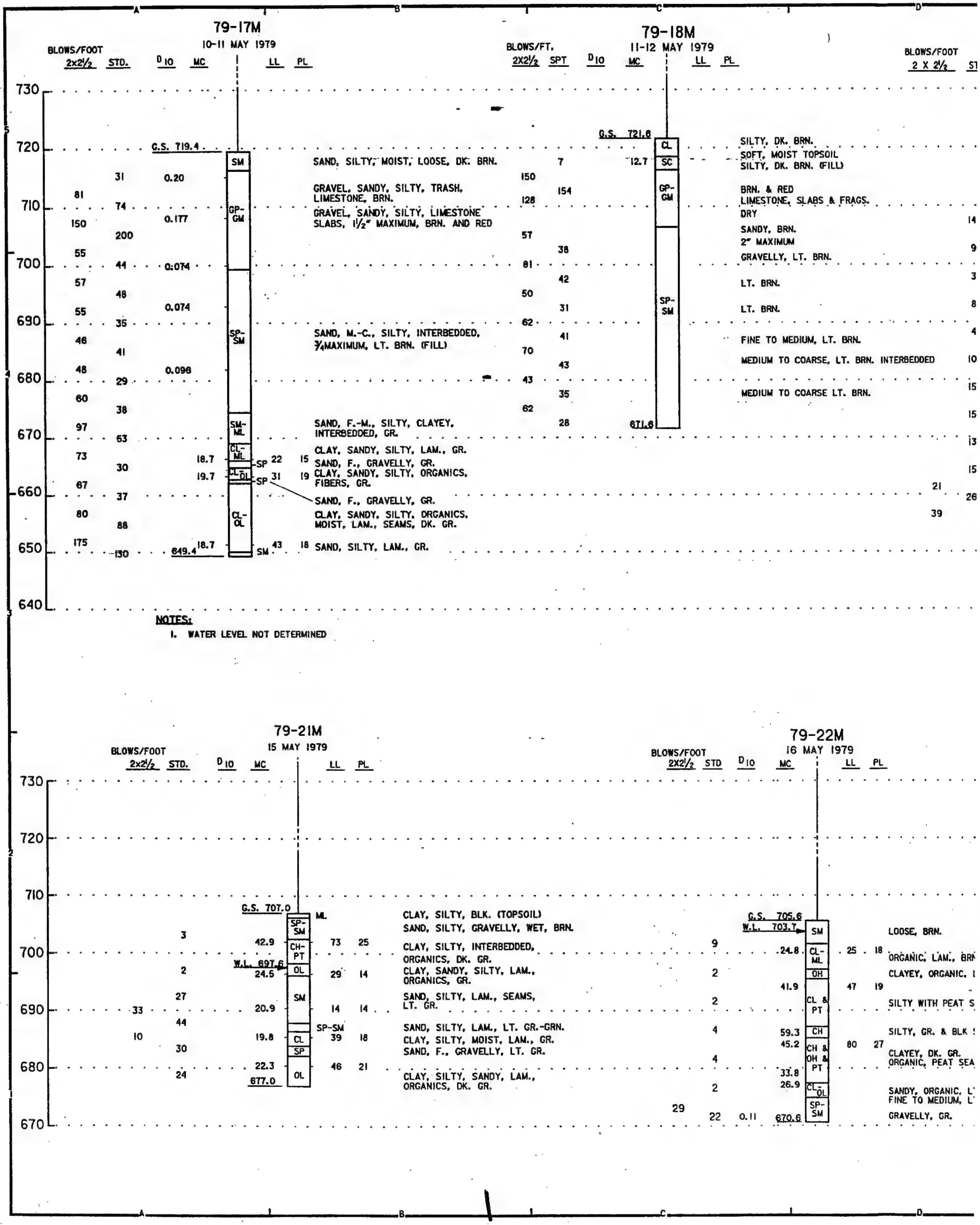
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

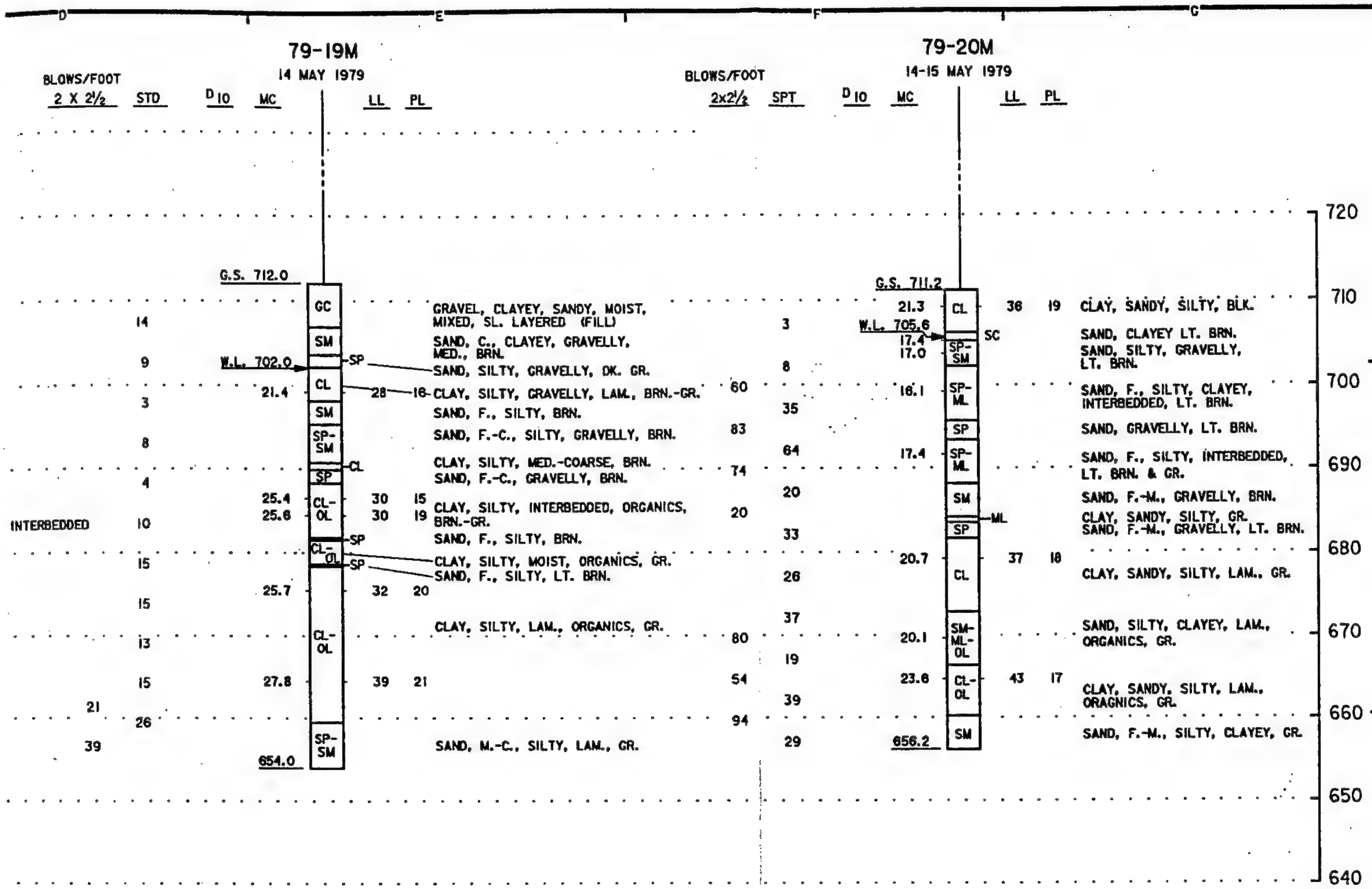
AE APPROVING OFFICIAL:

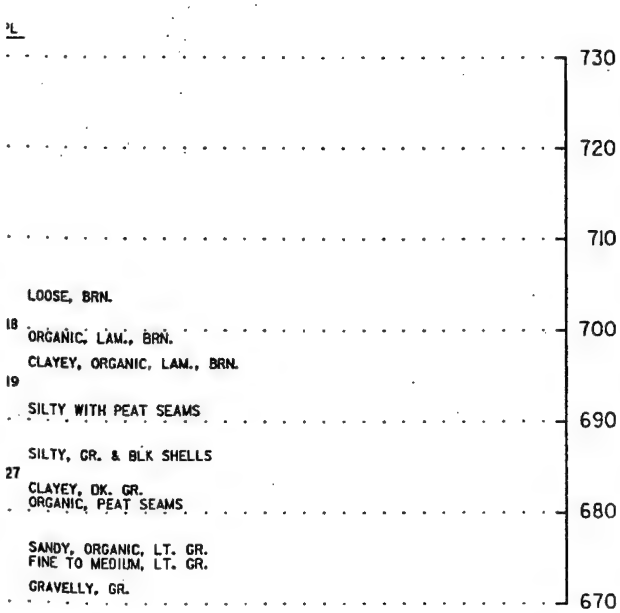
DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA CREEK STAGE 4 — CHASKA, MINNESOTA
BORING LOGS
BORING LOGS 79-11M THRU 79-16M

ED-D: DESIGNED: / CHECKED: / DRAWN: GRS
ED-GH: DESIGNED: JRC/PAW / CHECKED: JRC/DWM
DATE: 05-04-91
CAD FILE NAME: CHASKA3.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE C-4
SHT 4 OF 14

2


79-17M
10-11 MAY 1979
BLOWS/FOOT
2x2½ STD.
D10 MC LL PL
G.S. 719.4
SAND, SILTY, MOIST, LOOSE, DK. BRN.
GRAVEL, SANDY, SILTY, TRASH, LIMESTONE, BRN.
GRAVEL, SANDY, SILTY, LIMESTONE SLABS, 1½" MAXIMUM, BRN. AND RED
SAND, M.-C., SILTY, INTERBEDDED, ¾ MAXIMUM, LT. BRN. (FILL)
SAND, F.-M., SILTY, CLAYEY, INTERBEDDED, GR.
CLAY, SANDY, SILTY, LAM., GR.
SAND, F., GRAVELLY, GR.
CLAY, SANDY, SILTY, ORGANICS, FIBERS, GR.
SAND, F., GRAVELLY, GR.
CLAY, SANDY, SILTY, ORGANICS, MOIST, LAM., SEAMS, DK. GR.
SAND, SILTY, LAM., GR.
649.4
79-18M
11-12 MAY 1979
BLOWS/FT.
2X2½ SPT D10 MC LL PL
G.S. 721.6
SILTY, DK. BRN.
SOFT, MOIST TOPSOIL
SILTY, DK. BRN. (FILL)
BRN. & RED
LIMESTONE, SLABS & FRAGS.
DRY
SANDY, BRN.
2" MAXIMUM
GRAVELLY, LT. BRN.
LT. BRN.
LT. BRN.
FINE TO MEDIUM, LT. BRN.
MEDIUM TO COARSE, LT. BRN. INTERBEDDED
MEDIUM TO COARSE LT. BRN.
671.6
BLOWS/FOOT
2 X 2½
NOTES:
1. WATER LEVEL NOT DETERMINED
79-21M
15 MAY 1979
BLOWS/FOOT
2x2½ STD. D10 MC LL PL
G.S. 707.0
W.L. 697.6
CLAY, SILTY, BLK. (TOPSOIL)
SAND, SILTY, GRAVELLY, WET, BRN.
CLAY, SILTY, INTERBEDDED, ORGANICS, DK. GR.
CLAY, SANDY, SILTY, LAM., ORGANICS, GR.
SAND, SILTY, LAM., SEAMS, LT. GR.
SAND, SILTY, LAM., LT. GR.-GRN.
CLAY, SILTY, MOIST, LAM., GR.
SAND, F., GRAVELLY, LT. GR.
CLAY, SILTY, SANDY, LAM., ORGANICS, DK. GR.
677.0
79-22M
16 MAY 1979
BLOWS/FOOT
2X2½ STD D10 MC LL PL
G.S. 705.6
W.L. 703.7
LOOSE, BRN.
ORGANIC, LAM., BRN
CLAYEY, ORGANIC, L
SILTY WITH PEAT S
SILTY, GR. & BLK
CLAYEY, DK. GR.
ORGANIC, PEAT SEA
SANDY, ORGANIC, L
FINE TO MEDIUM, L
GRAVELLY, GR.
670.6





SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

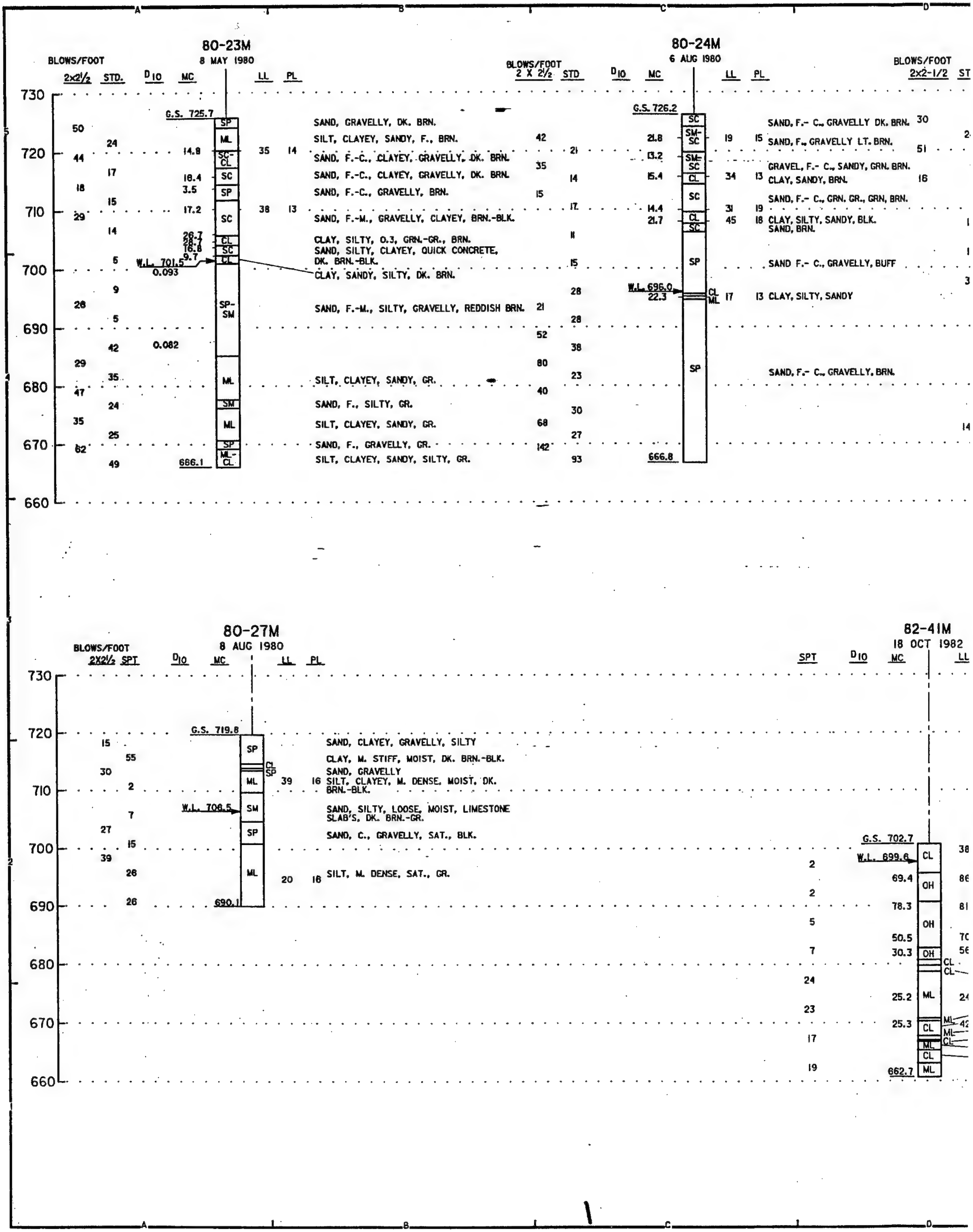
AE APPROVING OFFICIAL:

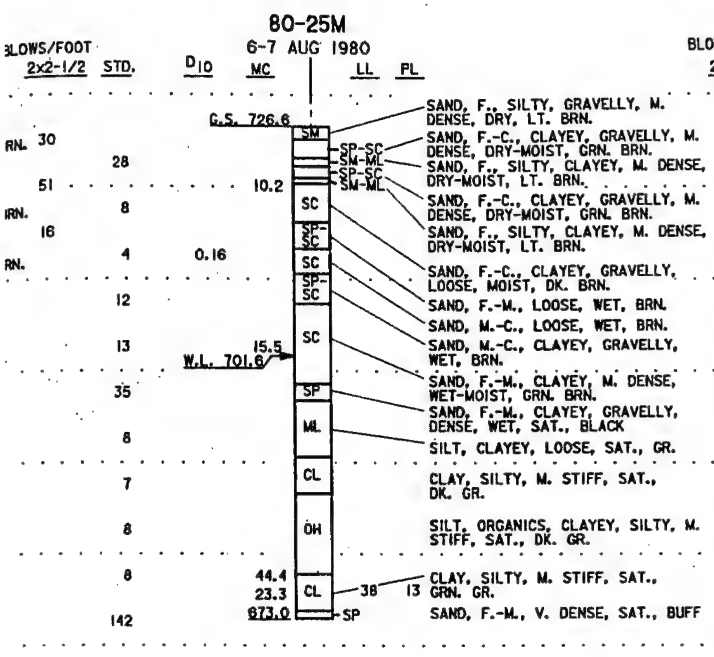
DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA CREEK STAGE 4 CHASKA, MINNESOTA
BORING LOGS
BORING LOGS 79-17M THRU 79-22M

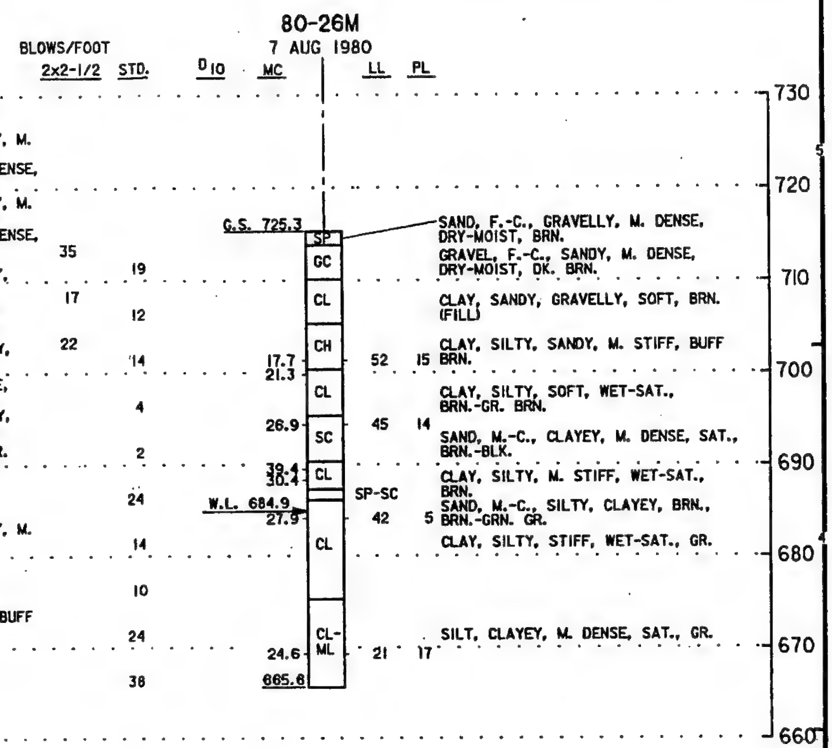
ED-D DESIGNED:
CHECKED:
DRAWN: GRS
ED-GH DESIGNED: JRC/PAW
CHECKED: JRC/DWM
DATE: 05-04-91

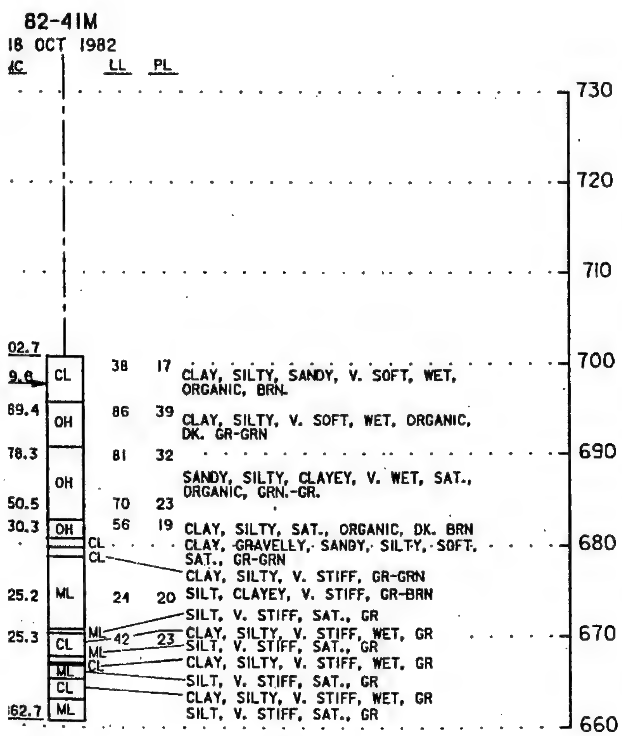
CAD FILE NAME: CHASKA4.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE C-5
SHT 5 OF 14

2


80-23M
8 MAY 1980
BLOWS/FOOT
2x2½ STD. D10 MC LL PL
G.S. 725.7
SAND, GRAVELLY, DK. BRN.
SILT, CLAYEY, SANDY, F., BRN.
SAND, F.-C., CLAYEY, GRAVELLY, DK. BRN.
SAND, F.-C., CLAYEY, GRAVELLY, DK. BRN.
SAND, F.-C., GRAVELLY, BRN.
SAND, F.-M., GRAVELLY, CLAYEY, BRN.-BLK.
CLAY, SILTY, 0.3, GRN.-GR., BRN.
SAND, SILTY, CLAYEY, QUICK CONCRETE, DK. BRN.-BLK.
CLAY, SANDY, SILTY, DK. BRN.
W.L. 701.5
0.093
SAND, F.-M., SILTY, GRAVELLY, REDDISH BRN.
0.082
SILT, CLAYEY, SANDY, GR.
SAND, F., SILTY, GR.
SILT, CLAYEY, SANDY, GR.
SAND, F., GRAVELLY, GR.
SILT, CLAYEY, SANDY, SILTY, GR.
686.1
80-24M
6 AUG 1980
BLOWS/FOOT
2 X 2½ STD D10 MC LL PL
G.S. 726.2
SAND, F.- C., GRAVELLY DK. BRN.
SAND, F., GRAVELLY LT. BRN.
GRAVEL, F.- C., SANDY, GRN. BRN.
CLAY, SANDY, BRN.
SAND, F.- C., GRN. GR., GRN. BRN.
CLAY, SILTY, SANDY, BLK.
SAND, BRN.
SAND F.- C., GRAVELLY, BUFF
W.L. 696.0
22.3
CLAY, SILTY, SANDY
SAND, F.- C., GRAVELLY, BRN.
666.8
BLOWS/FOOT
2x2-1/2 ST
80-27M
8 AUG 1980
BLOWS/FOOT
2X2½ SPT D10 MC LL PL
G.S. 719.8
SAND, CLAYEY, GRAVELLY, SILTY
CLAY, M. STIFF, MOIST, DK. BRN.-BLK.
SAND, GRAVELLY
SILT, CLAYEY, M. DENSE, MOIST, DK. BRN.-BLK.
W.L. 706.5
SAND, SILTY, LOOSE, MOIST, LIMESTONE SLAB'S, DK. BRN.-GR.
SAND, C., GRAVELLY, SAT., BLK.
SILT, M. DENSE, SAT., GR.
690.1
82-41M
18 OCT 1982
SPT D10 MC LL
G.S. 702.7
W.L. 699.6
662.7







SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2

CHASKA STAGE 4

FLOOD CONTROL - MINNESOTA RIVER

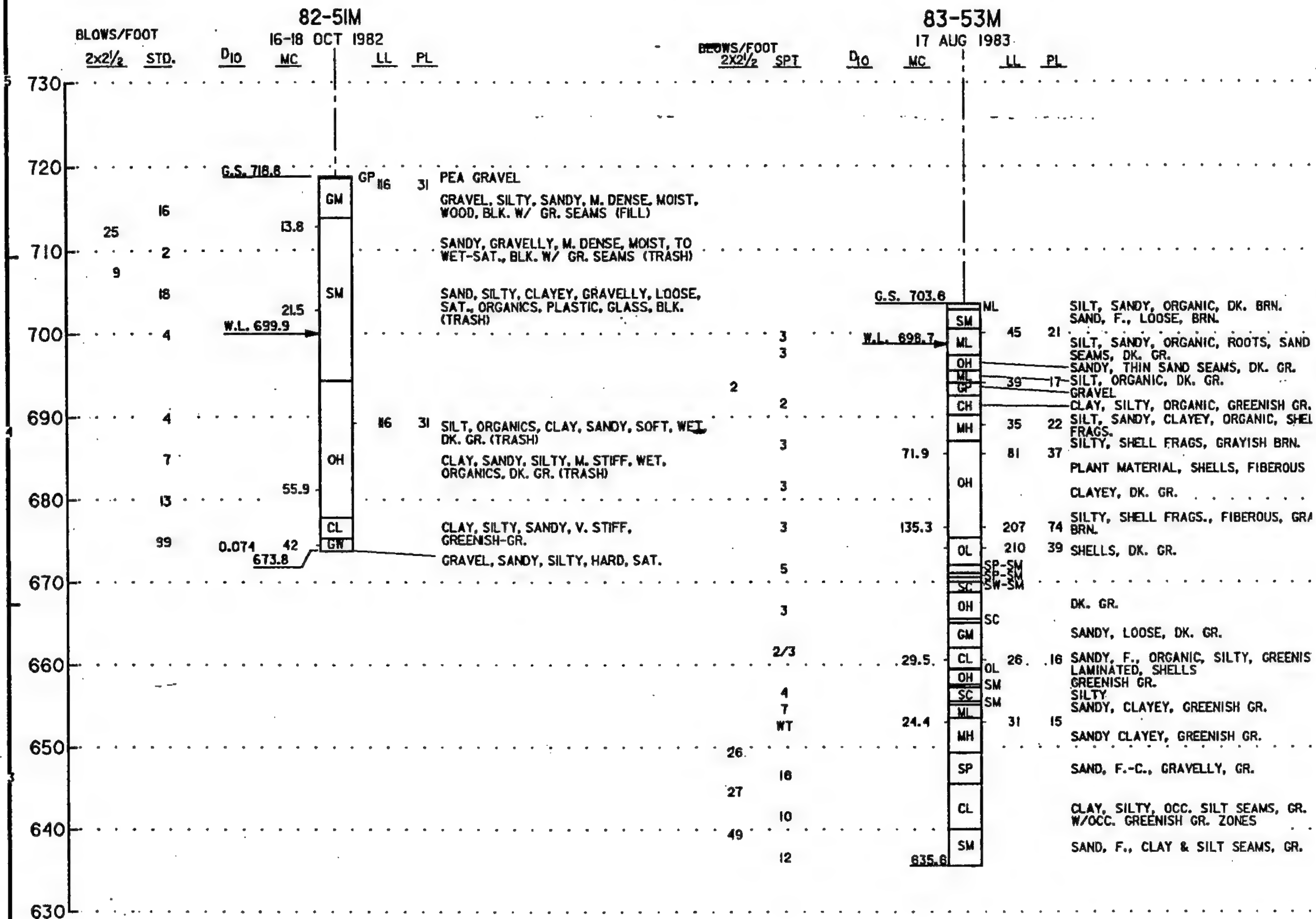
CHASKA CREEK STAGE 4 — CHASKA, MINNESOTA

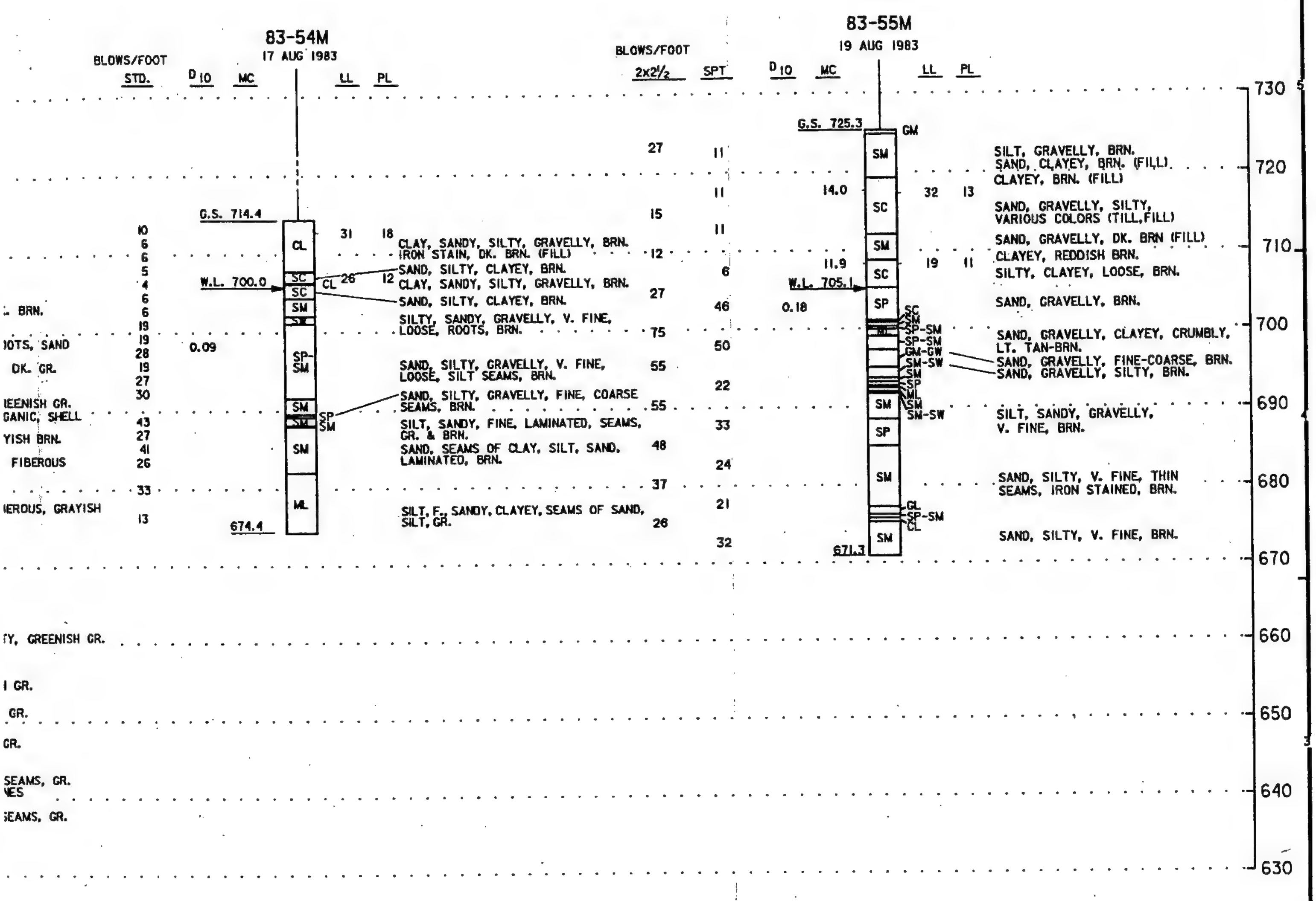
BORING LOGS

BORING LOGS 80-23M THRU 80-27M & 82-41M

ED-D: DESIGNED: / CHECKED: / DRAWN: GRS
ED-GH: DESIGNED: JRC/PAW / CHECKED: JRC/DWM
DATE: 05-04-91
CAD FILE NAME: CHASKA5.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE C-6
SHT 6 OF 14

2


82-51M
16-18 OCT 1982
BLOWS/FOOT
2x2½ STD.
D10 MC LL PL
83-53M
17 AUG 1983
BLOWS/FOOT
2X2½ SPT
D10 MC LL PL
730
720
710
700
690
680
670
660
650
640
630
G.S. 718.8
W.L. 699.9
673.8
PEA GRAVEL
GRAVEL, SILTY, SANDY, M. DENSE, MOIST, WOOD, BLK. W/ GR. SEAMS (FILL)
SANDY, GRAVELLY, M. DENSE, MOIST, TO WET-SAT., BLK. W/ GR. SEAMS (TRASH)
SAND, SILTY, CLAYEY, GRAVELLY, LOOSE, SAT., ORGANICS, PLASTIC, GLASS, BLK. (TRASH)
SILT, ORGANICS, CLAY, SANDY, SOFT, WET, DK. GR. (TRASH)
CLAY, SANDY, SILTY, M. STIFF, WET, ORGANICS, DK. GR. (TRASH)
CLAY, SILTY, SANDY, V. STIFF, GREENISH-GR.
GRAVEL, SANDY, SILTY, HARD, SAT.
G.S. 703.6
W.L. 698.7
635.6
SILT, SANDY, ORGANIC, DK. BRN.
SAND, F., LOOSE, BRN.
SILT, SANDY, ORGANIC, ROOTS, SAND SEAMS, DK. GR.
SANDY, THIN SAND SEAMS, DK. GR.
SILT, ORGANIC, DK. GR.
GRAVEL
CLAY, SILTY, ORGANIC, GREENISH GR.
SILT, SANDY, CLAYEY, ORGANIC, SHELL FRAGS.
SILTY, SHELL FRAGS, GRAYISH BRN.
PLANT MATERIAL, SHELLS, FIBEROUS
CLAYEY, DK. GR.
SILTY, SHELL FRAGS., FIBEROUS, GRAY BRN.
SHELLS, DK. GR.
DK. GR.
SANDY, LOOSE, DK. GR.
SANDY, F., ORGANIC, SILTY, GREENISH LAMINATED, SHELLS
GREENISH GR.
SILTY
SANDY, CLAYEY, GREENISH GR.
SANDY CLAYEY, GREENISH GR.
SAND, F.-C., GRAVELLY, GR.
CLAY, SILTY, OCC. SILT SEAMS, GR. W/OCC. GREENISH GR. ZONES
SAND, F., CLAY & SILT SEAMS, GR.



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

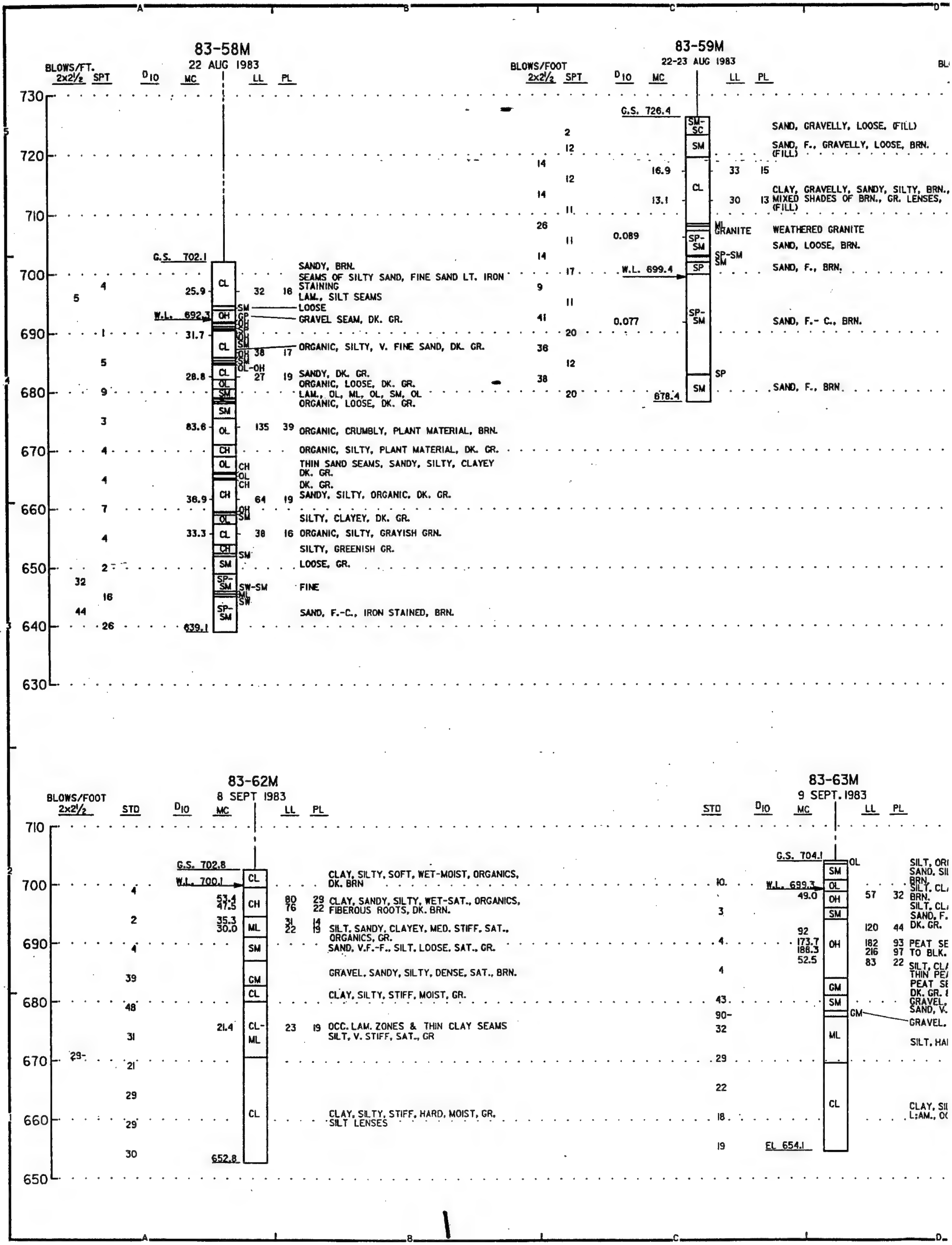
DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA CREEK STAGE 4 CHASKA, MINNESOTA
BORING LOGS
BORING LOGS 82-51M & 83-53M THRU 83-55M

ED-D	
DESIGNED:	
CHECKED:	
DRAWN:	GRS

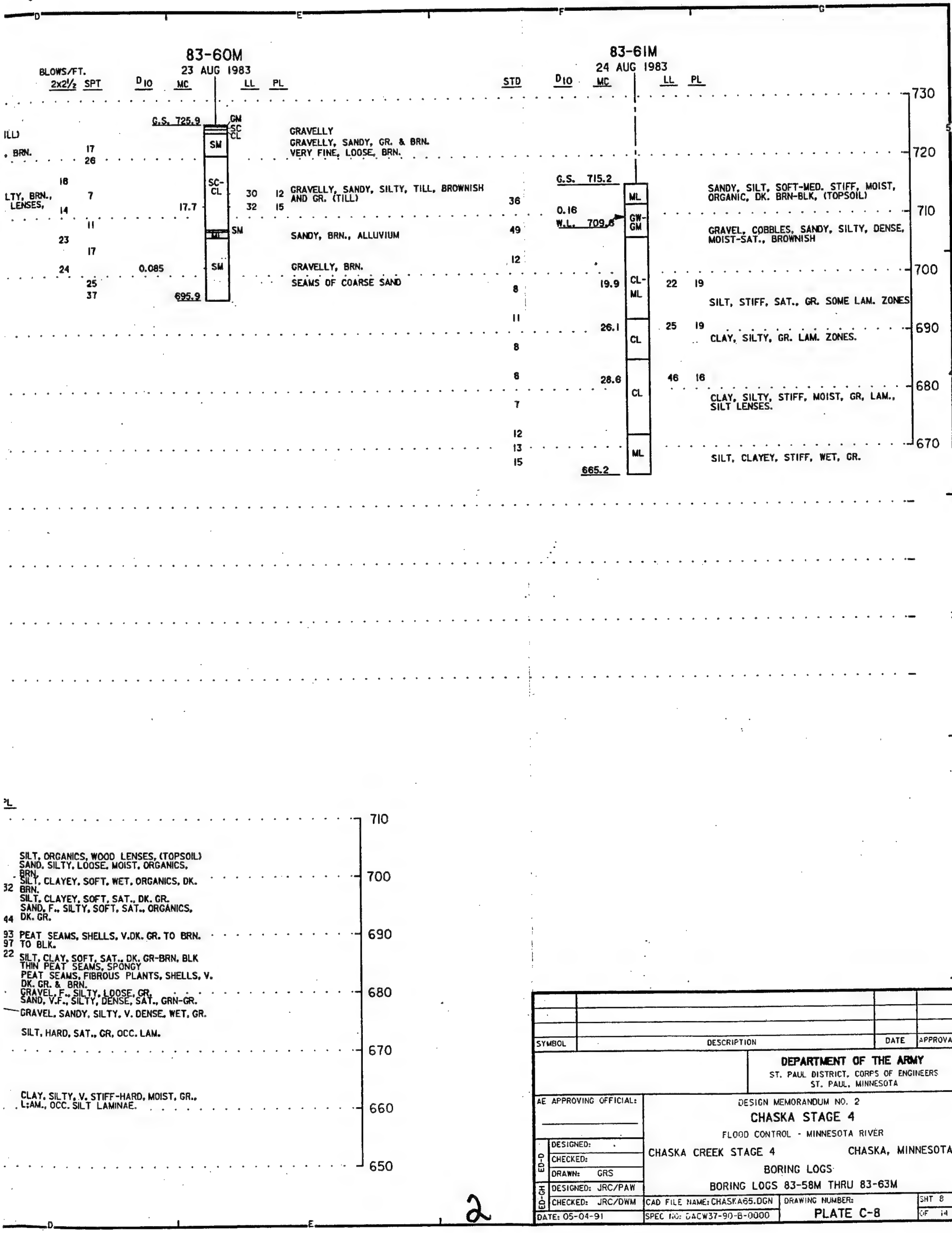
ED-GH	
DESIGNED:	JRC/PAW
CHECKED:	JRC/DWM

DATE: 05-04-91
CAD FILE NAME: CHASKA6.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE C-7
SHT 7 OF 14

2



83-58M
22 AUG 1983
BLOWS/FT.
2x2½ SPT
D10 MC LL PL
G.S. 702.1
W.L. 692.3
SANDY, BRN.
SEAMS OF SILTY SAND, FINE SAND LT. IRON STAINING
LAM., SILT SEAMS
LOOSE
GRAVEL SEAM, DK. GR.
ORGANIC, SILTY, V. FINE SAND, DK. GR.
SANDY, DK. GR.
ORGANIC, LOOSE, DK. GR.
LAM., OL, ML, OL, SM, OL
ORGANIC, LOOSE, DK. GR.
ORGANIC, CRUMBLY, PLANT MATERIAL, BRN.
ORGANIC, SILTY, PLANT MATERIAL, DK. GR.
THIN SAND SEAMS, SANDY, SILTY, CLAYEY DK. GR.
DK. GR.
SANDY, SILTY, ORGANIC, DK. GR.
SILTY, CLAYEY, DK. GR.
ORGANIC, SILTY, GRAYISH GRN.
SILTY, GREENISH GR.
LOOSE, GR.
FINE
SAND, F.-C., IRON STAINED, BRN.
639.1
83-59M
22-23 AUG 1983
BLOWS/FOOT
2x2½ SPT
D10 MC LL PL
G.S. 726.4
W.L. 699.4
SAND, GRAVELLY, LOOSE, (FILL)
SAND, F., GRAVELLY, LOOSE, BRN. (FILL)
CLAY, GRAVELLY, SANDY, SILTY, BRN., MIXED SHADES OF BRN., GR. LENSES, (FILL)
WEATHERED GRANITE
SAND, LOOSE, BRN.
SAND, F., BRN.
SAND, F.- C., BRN.
SAND, F., BRN.
678.4
83-62M
8 SEPT 1983
BLOWS/FOOT
2x2½ STD D10 MC LL PL
G.S. 702.8
W.L. 700.1
CLAY, SILTY, SOFT, WET-MOIST, ORGANICS, DK. BRN
CLAY, SANDY, SILTY, WET-SAT., ORGANICS, FIBEROUS ROOTS, DK. BRN.
SILT, SANDY, CLAYEY, MED. STIFF, SAT., ORGANICS, GR.
SAND, V.F.-F., SILT, LOOSE, SAT., GR.
GRAVEL, SANDY, SILTY, DENSE, SAT., BRN.
CLAY, SILTY, STIFF, MOIST, GR.
OCC. LAM. ZONES & THIN CLAY SEAMS
SILT, V. STIFF, SAT., GR
CLAY, SILTY, STIFF, HARD, MOIST, GR, SILT LENSES
652.8
83-63M
9 SEPT. 1983
STD D10 MC LL PL
G.S. 704.1
W.L. 699.3
EL 654.1



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

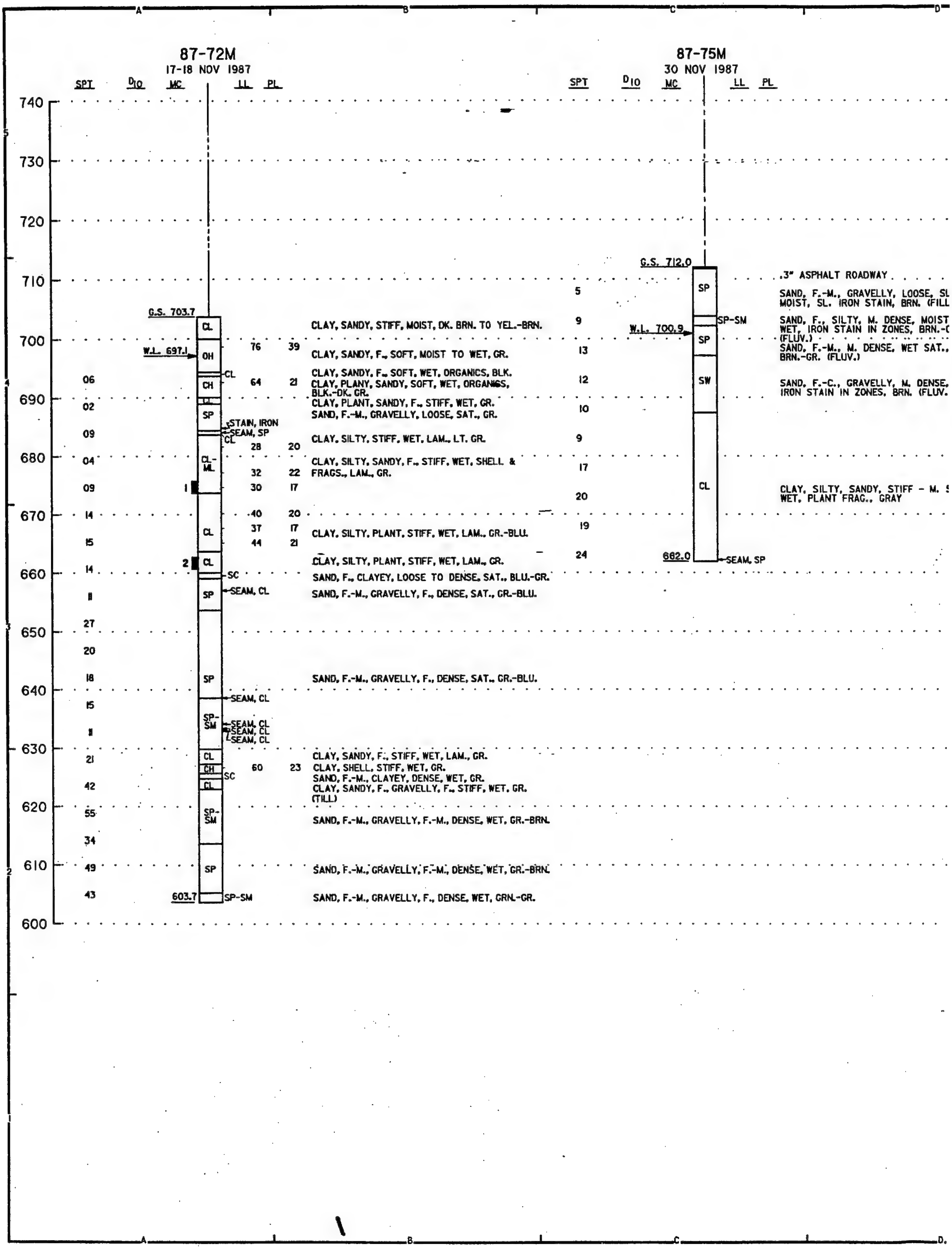
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA CREEK STAGE 4 CHASKA, MINNESOTA
BORING LOGS
BORING LOGS 83-58M THRU 83-63M

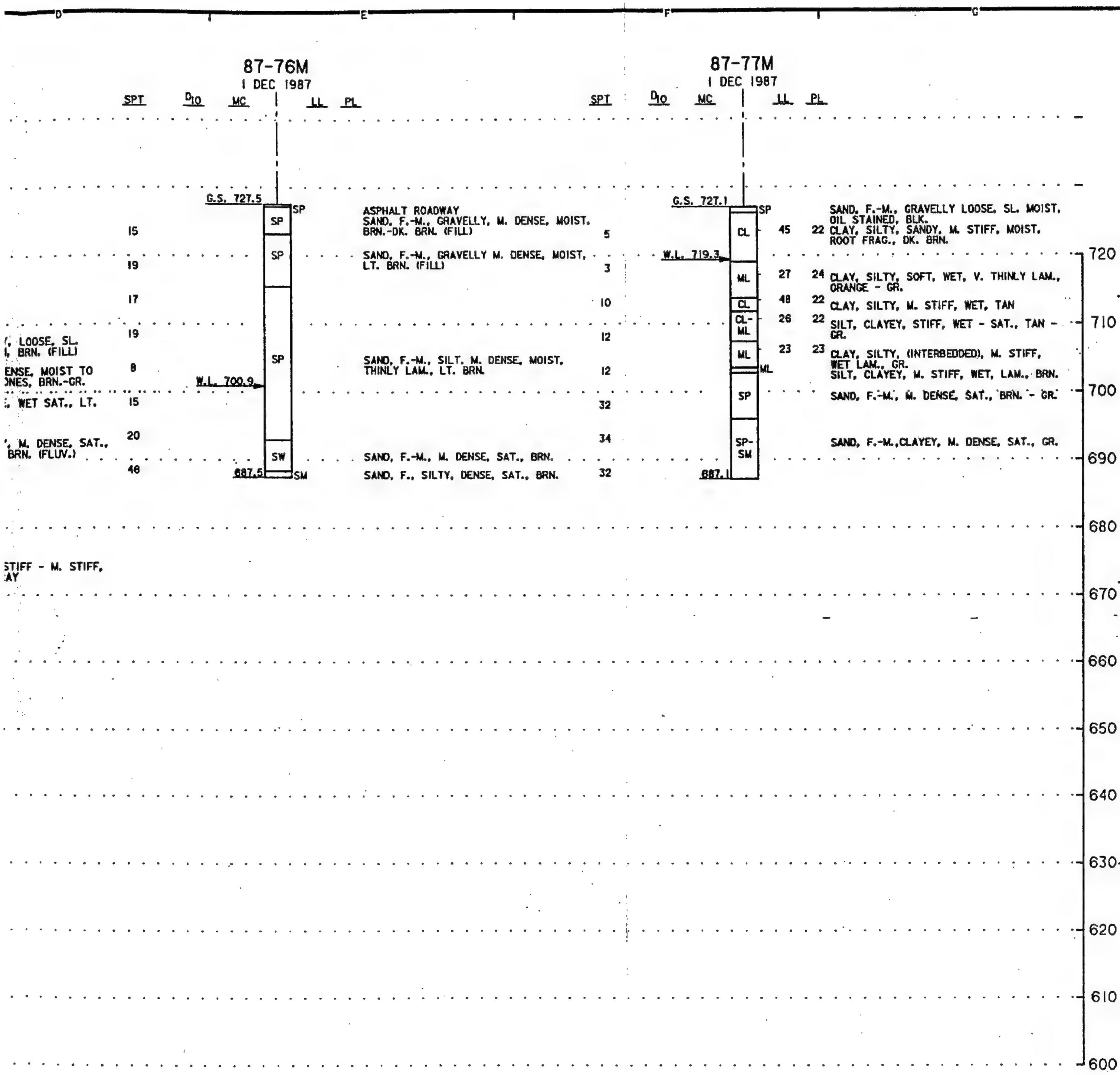
ED-D	DESIGNED:
	CHECKED:
	DRAWN: GRS
ED-GH	DESIGNED: JRC/PAW
	CHECKED: JRC/DWM

DATE: 05-04-91
CAD FILE NAME: CHASKA65.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE C-8
SHT 8 OF 14

2



87-72M
17-18 NOV 1987
SPT
D10
MC
LL
PL
87-75M
30 NOV 1987
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
G.S. 703.7
W.L. 697.1
603.7
G.S. 712.0
W.L. 700.9
662.0
CL
OH
CH
SP
CL-ML
SP-SM
SC
SW
STAIN, IRON
SEAM, SP
SEAM, CL
CLAY, SANDY, STIFF, MOIST, DK. BRN. TO YEL.-BRN.
CLAY, SANDY, F., SOFT, MOIST TO WET, GR.
CLAY, SANDY, F., SOFT, WET, ORGANICS, BLK.
CLAY, PLANY, SANDY, SOFT, WET, ORGANICS, BLK.-DK. GR.
CLAY, PLANT, SANDY, F., STIFF, WET, GR.
SAND, F.-M., GRAVELLY, LOOSE, SAT., GR.
CLAY, SILTY, STIFF, WET, LAM., LT. GR.
CLAY, SILTY, SANDY, F., STIFF, WET, SHELL & FRAGS., LAM., GR.
CLAY, SILTY, PLANT, STIFF, WET, LAM., GR.-BLU.
CLAY, SILTY, PLANT, STIFF, WET, LAM., GR.
SAND, F., CLAYEY, LOOSE TO DENSE, SAT., BLU.-GR.
SAND, F.-M., GRAVELLY, F., DENSE, SAT., GR.-BLU.
SAND, F.-M., GRAVELLY, F., DENSE, SAT., GR.-BLU.
CLAY, SANDY, F., STIFF, WET, LAM., GR.
CLAY, SHELL, STIFF, WET, GR.
SAND, F.-M., CLAYEY, DENSE, WET, GR.
CLAY, SANDY, F., GRAVELLY, F., STIFF, WET, GR. (TILL)
SAND, F.-M., GRAVELLY, F.-M., DENSE, WET, GR.-BRN.
SAND, F.-M., GRAVELLY, F.-M., DENSE, WET, GR.-BRN.
SAND, F.-M., GRAVELLY, F., DENSE, WET, GRN.-GR.
.3" ASPHALT ROADWAY
SAND, F.-M., GRAVELLY, LOOSE, SL MOIST, SL. IRON STAIN, BRN. (FILL
SAND, F., SILTY, M. DENSE, MOIST WET, IRON STAIN IN ZONES, BRN.-((FLUV.)
SAND, F.-M., M. DENSE, WET SAT., BRN.-GR. (FLUV.)
SAND, F.-C., GRAVELLY, M. DENSE, IRON STAIN IN ZONES, BRN. (FLUV.
CLAY, SILTY, SANDY, STIFF - M. WET, PLANT FRAG., GRAY



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

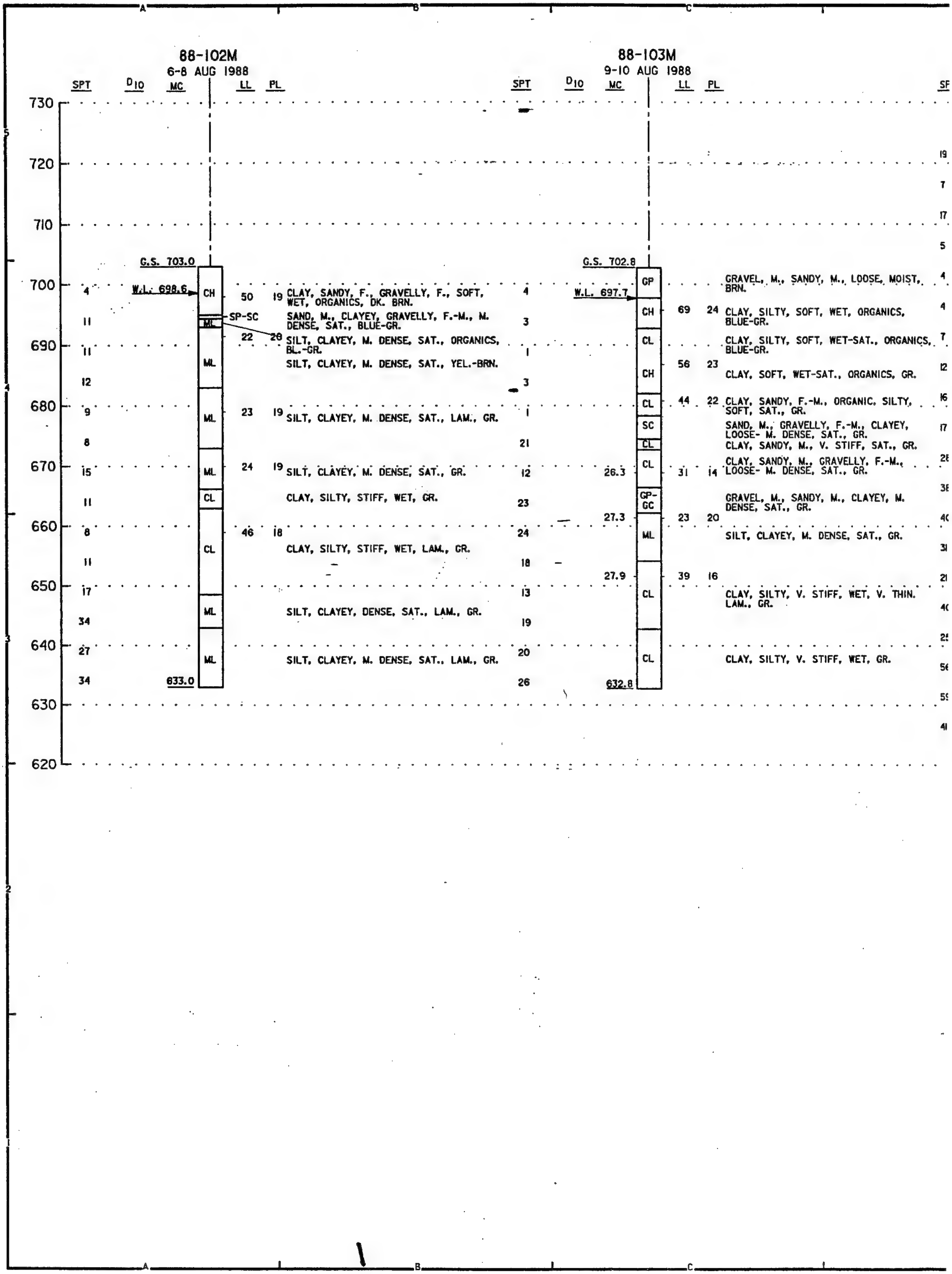
AE APPROVING OFFICIAL:

ED-D: DESIGNED: ; CHECKED: ; DRAWN: GRS
ED-GH: DESIGNED: JRC/PAW ; CHECKED: JRC/DWM
DATE: 05-04-91

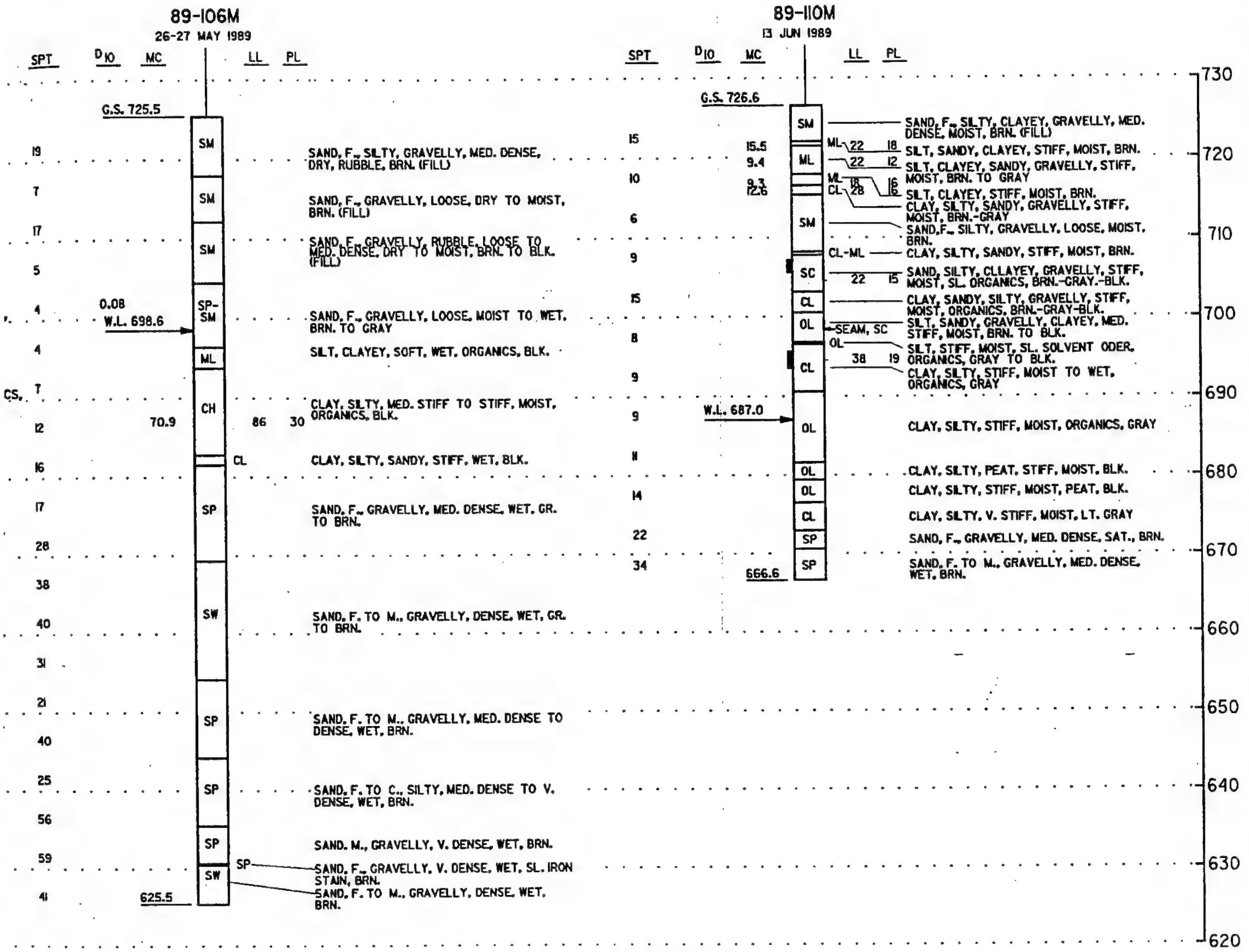
DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA CREEK STAGE 4 CHASKA, MINNESOTA
BORING LOGS
BORING LOGS 87-72M, & 87-75M, THRU 87-77M

CAD FILE NAME: CHASKA7.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE C-9
SHT 9 OF 14

2



88-102M
6-8 AUG 1988
SPT
D10
MC
LL
PL
88-103M
9-10 AUG 1988
730
720
710
700
690
680
670
660
650
640
630
620
G.S. 703.0
W.L. 698.6
CH
SP-SC
ML
CL
50
19
22
28
23
19
24
19
46
18
CLAY, SANDY, F., GRAVELLY, F., SOFT, WET, ORGANICS, DK. BRN.
SAND, M., CLAYEY, GRAVELLY, F.-M., M. DENSE, SAT., BLUE-GR.
SILT, CLAYEY, M. DENSE, SAT., ORGANICS, BL.-GR.
SILT, CLAYEY, M. DENSE, SAT., YEL.-BRN.
SILT, CLAYEY, M. DENSE, SAT., LAM., GR.
SILT, CLAYEY, M. DENSE, SAT., GR.
CLAY, SILTY, STIFF, WET, GR.
CLAY, SILTY, STIFF, WET, LAM., GR.
SILT, CLAYEY, DENSE, SAT., LAM., GR.
SILT, CLAYEY, M. DENSE, SAT., LAM., GR.
4
11
11
12
9
8
15
11
8
11
17
34
27
34
633.0
G.S. 702.8
W.L. 697.7
GP
SC
GP-GC
26.3
27.3
27.9
632.8
69
24
56
23
44
22
31
14
23
20
39
16
GRAVEL, M., SANDY, M., LOOSE, MOIST, BRN.
CLAY, SILTY, SOFT, WET, ORGANICS, BLUE-GR.
CLAY, SILTY, SOFT, WET-SAT., ORGANICS, BLUE-GR.
CLAY, SOFT, WET-SAT., ORGANICS, GR.
CLAY, SANDY, F.-M., ORGANIC, SILTY, SOFT, SAT., GR.
SAND, M., GRAVELLY, F.-M., CLAYEY, LOOSE- M. DENSE, SAT., GR.
CLAY, SANDY, M., V. STIFF, SAT., GR.
CLAY, SANDY, M., GRAVELLY, F.-M., LOOSE- M. DENSE, SAT., GR.
GRAVEL, M., SANDY, M., CLAYEY, M. DENSE, SAT., GR.
SILT, CLAYEY, M. DENSE, SAT., GR.
CLAY, SILTY, V. STIFF, WET, V. THIN. LAM., GR.
CLAY, SILTY, V. STIFF, WET, GR.
4
3
1
3
1
21
12
23
24
18
13
19
20
26
A
B
C



NOTES:

1. WATER LEVEL DETERMINED AFTER 30 MINUTES WITH:
   BOTTOM OF HSA AT EL. 686.5
   BOTTOM OF HOLE AT EL. 689.5
   AFTER SAMPLING TO EL. 685.5
2. HSA ADVANCED TO EL. 686.5 AND DRILLING MUD USED BELOW.
3. WATER LOSS WHILE ADVANCING HOLE VARIED BETWEEN 0 AND 20 GPM BELOW EL. 686.5.
4. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

NOTES:

1. WATER LEVEL DTERMINED AFTER 2 HOURS WITH:
   BOTTOM OF AUGER AT EL. 676.6
   BOTTOM OF HOLE AT EL. 680.2
   AFTER SAMPLING TO EL. 671.6
2. HOLLOW STEM AUGER SET TO EL. 672.6. HOLE STABILIZED WITH DRILLING MUD FROM EL. 672.6 TO EL. 666.6.
3. WATER LOSS BETWEEN EL. 672.6 AND 671.6 = 5 GPM.
4. TWO - 5" UNDISTURBED SAMPLES TAKEN IN AN OFFSET HOLE AT EL. 705.6 AND AT EL. 695.6.
5. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT, BEFORE CASING WAS PULLED.

SYMBOL	DESCRIPTION	DATE	APPROVAL

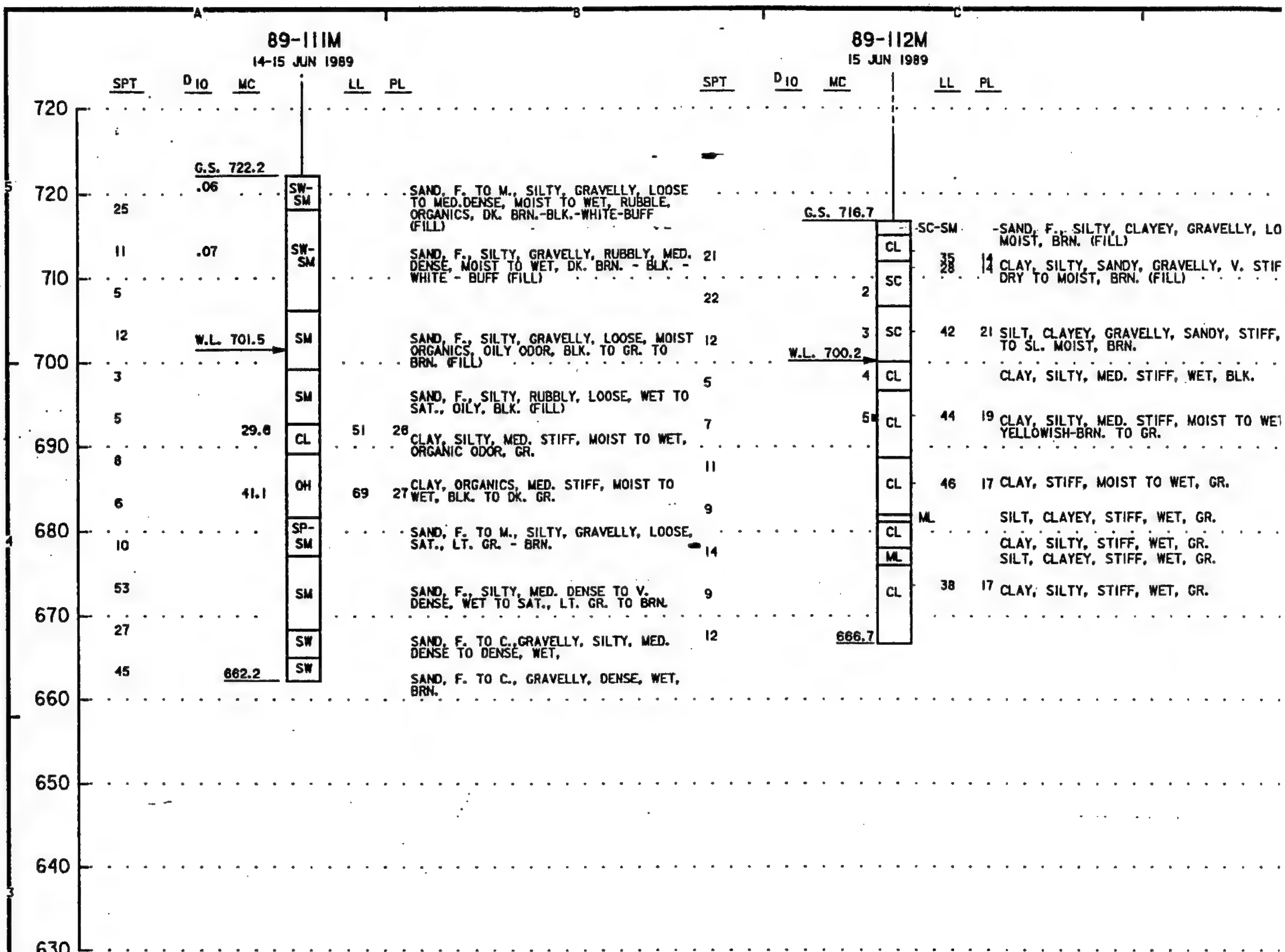
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA CREEK STAGE 4 — CHASKA, MINNESOTA
BORING LOGS
BORING LOGS 88-102M, 88-103M, 89-106M, & 89-110M

ED-D: DESIGNED: / CHECKED: / DRAWN: GRS
ED-GH: DESIGNED: JRC/PAW / CHECKED: JRC/DWM
DATE: 05-04-91
CAD FILE NAME: CHASKA8.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE C-10
SHT 10 OF 14

2

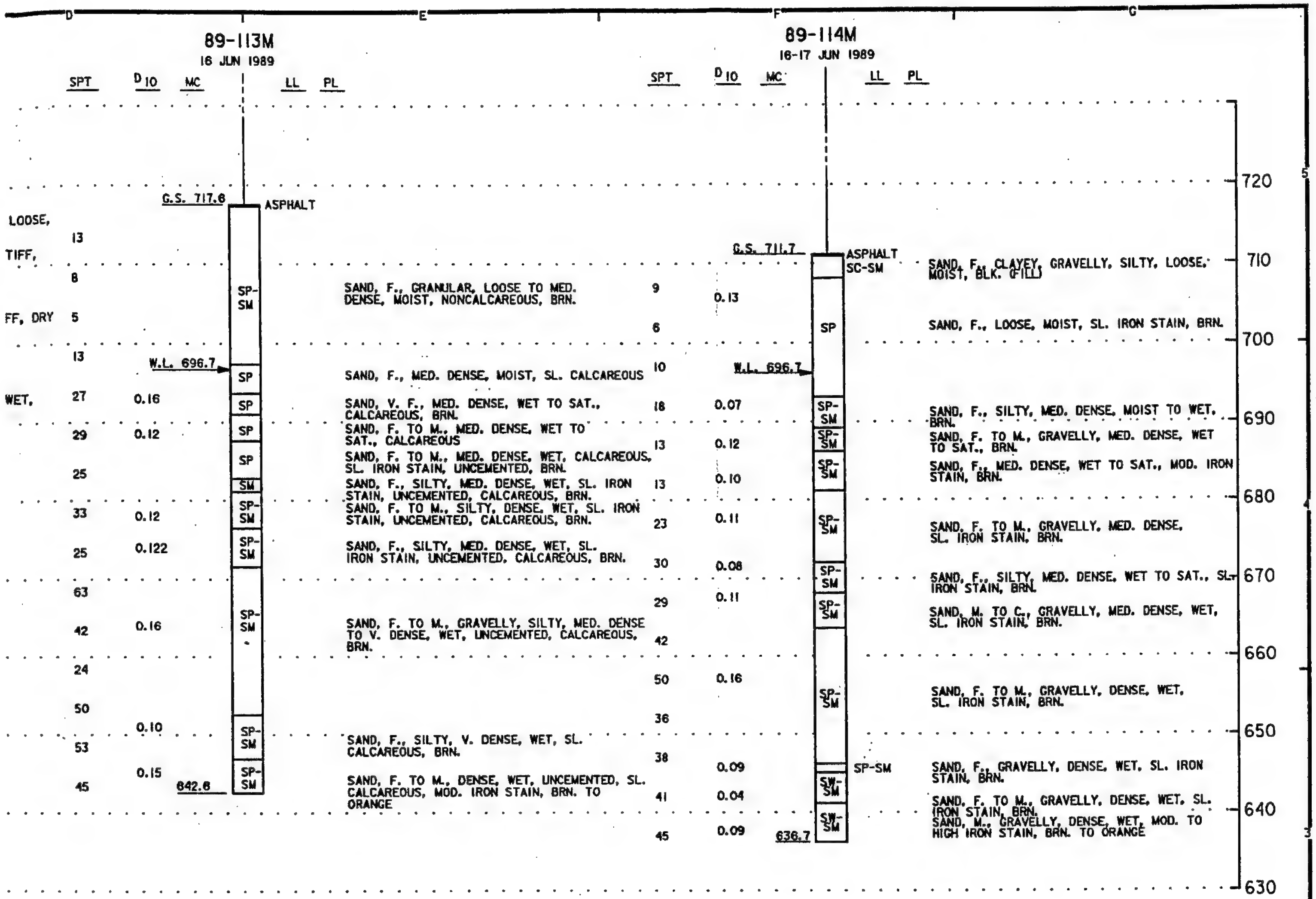


NOTES:

1. WATER LEVEL DETERMINED AFTER 17 HOURS WITH:
   BOTTOM OF AUGER AT EL. 697.2.
   BOTTOM OF HOLE AT EL. 696.9
   AFTER SAMPLING TO EL. 692.2.
2. HSA SET TO EL. 693.2. HOLE STABILIZED WITH DRILLING MUD BELOW 693.2'
3. WATER LOSS BELOW 693.2 WAS BETWEEN 1 AND 5 GPM
4. FOUR-3 INCH SHELBY TUBE UNDISTURBED SAMPLES TAKEN IN AN OFFSET HOLE.

NOTES:

1. WATER LEVEL DETERMINED AFTER 1 HOUR.
   BOTTOM OF AUGER AT EL. 701.7.
   BOTTOM OF HOLE AT EL. 699.4.
   AFTER SAMPLING TO EL. 696.7.
2. HOLLOW STEM AUGER SET TO ELEVATION 697.7. HOLE STABILIZED WITH DRILLING MUD BELOW ELEVATION 697.7.
3. NO WATER LOSS BELOW EL. 697.7.
4. FIVE -5" UNDISTURBED SAMPLES TAKEN IN AN OFFSET HOLE.
5. BACKFILLED HOLE WITH TREMIED CEMENT-BENTONITE GROUT.



NOTES:

1. WATER LEVEL DETERMINED AFTER 15 HOURS WITH:
   BOTTOM OF AUGER AT EL. 691.7.
   BOTTOM OF HOLE AT EL. 693.6.
   AFTER SAMPLING TO EL. 686.7.
2. HOLLOW STEM AUGER ADVANCED TO EL. 687.7 AND DRILLING MUD USED TO STABILIZE HOLE BELOW 687.7.
3. WATER LOSS BETWEEN EL. 687.7 AND BOTTOM OF HOLE = APPROXIMATELY 2 G.P.M.
4. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

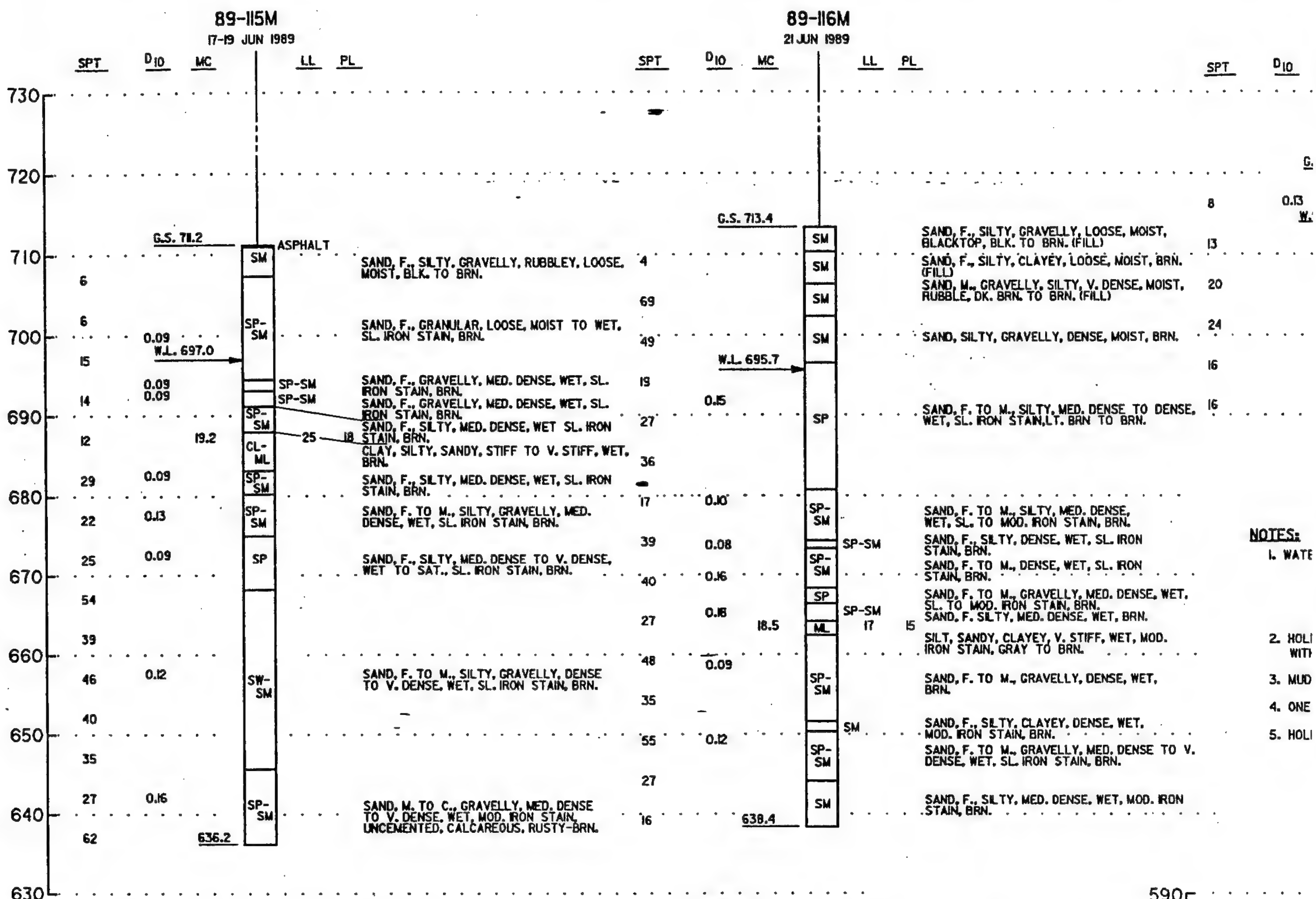
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA CREEK STAGE 4 — CHASKA, MINNESOTA
BORING LOGS
BORING LOGS 89-111M THRU 89-114M

ED-D DESIGNED:	
CHECKED:	
DRAWN:	GRS
ED-GH DESIGNED:	JRC/PAW
CHECKED:	JRC/DWM
DATE:	05-04-91

CAD FILE NAME: CHASKA9.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE C-11
SHT 11 OF 14

2

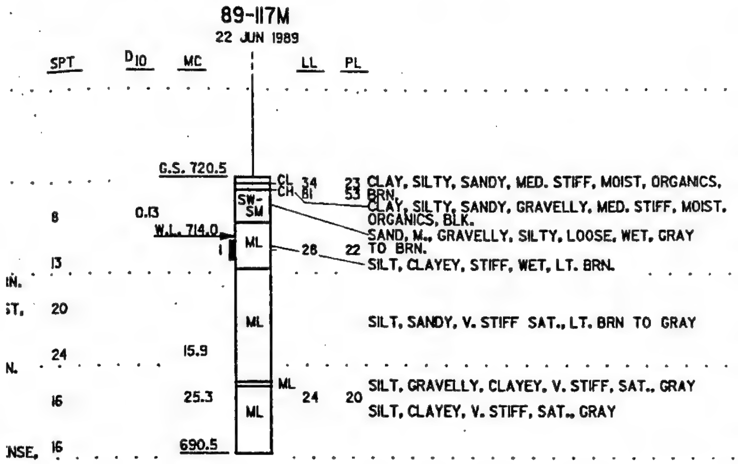


NOTES:

1. WATER LEVEL DETERMINED AFTER 36 HOURS WITH:
   BOTTOM OF AUGER = EL. 696.2.
   BOTTOM OF HOLE = EL. 696.2.
   AFTER SAMPLING TO EL. 691.2.
2. HOLLOW STEM AUGER SET TO EL. 692.2. HOLE STABILIZED WITH DRILLING MUD BELOW 692.2.
3. MUD LOSS = 2 GPM.
4. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

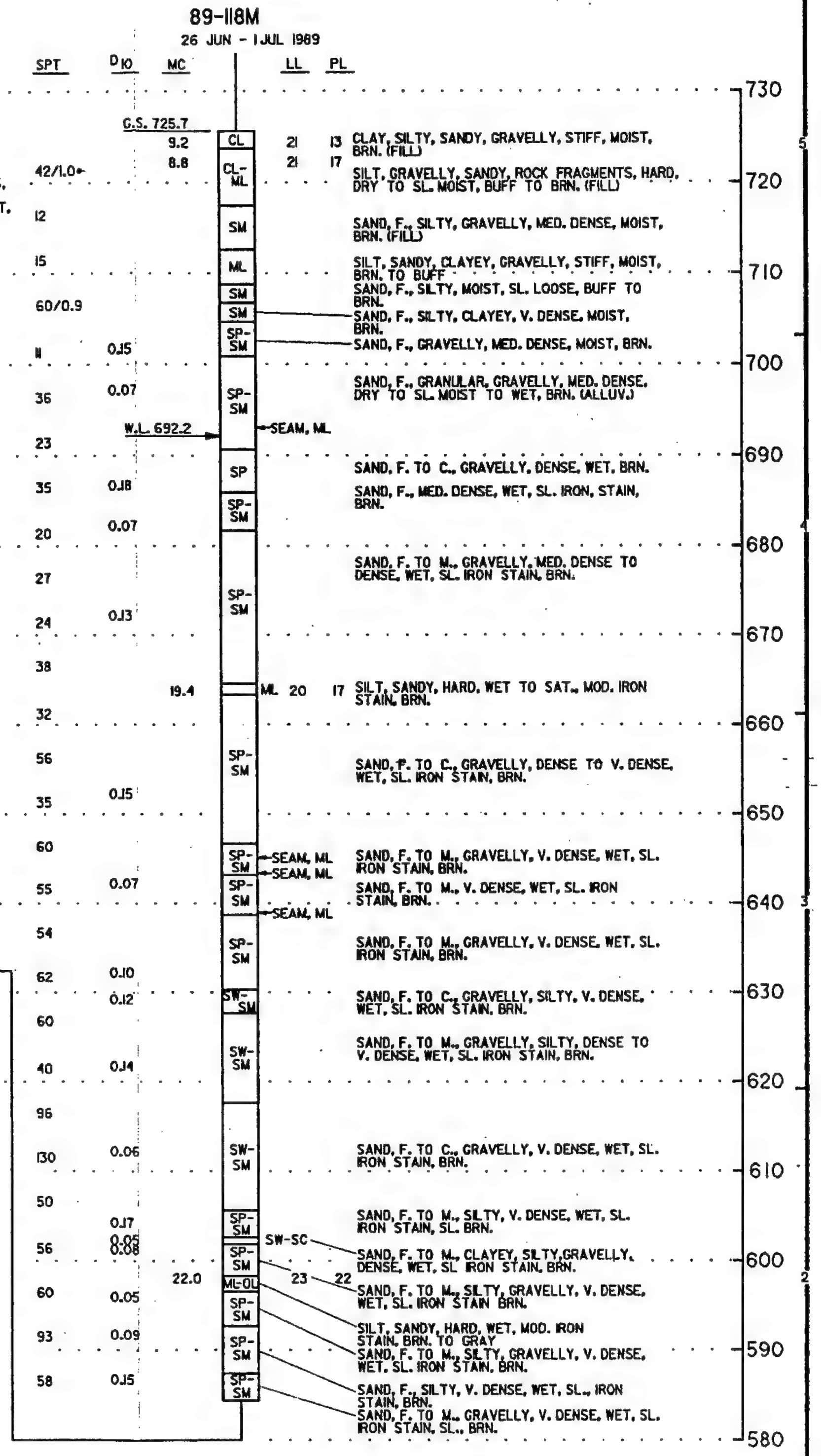
NOTES:

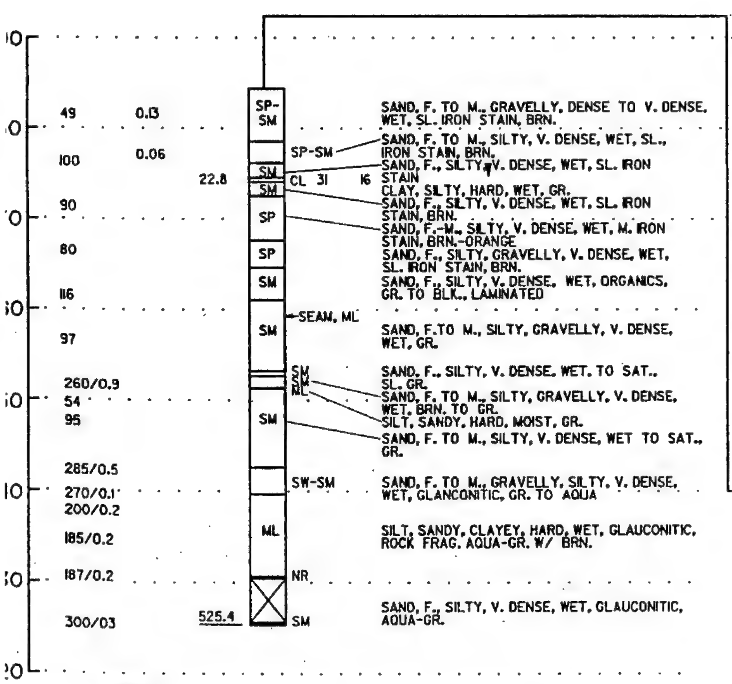
1. WATER LEVEL DETERMINED AFTER 30 MINUTES WITH:
   BOTTOM OF AUGER = EL. 693.4.
   BOTTOM OF HOLE = EL. 694.0
   AFTER SAMPLING TO EL. 688.4.
2. HSA SET TO 689.4. DRILLING MUD USED TO STABILIZE THE HOLE BELOW EL. 689.4.
3. MUD LOSS BELOW EL. 689.4 = 1-2 G.P.M.
4. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.



NOTES:

1. WATER LEVEL DETERMINED AFTER 30 MINUTES WITH:
   BOTTOM OF AUGER AT EL. 710.5.
   BOTTOM OF HOLE AT EL. 711.2.
   AFTER SAMPLING TO EL. 705.5.
2. HOLLOW STEM AUGER SET TO EL. 706.5. HOLE STABILIZED WITH BENTONITE DRILLING MUD BELOW EL. 706.5.
3. MUD LOSS BELOW EL. 706.5. = 0 G.P.M.
4. ONE - 5' TUBE SAMPLE TAKEN FROM EL. 713.5 TO EL. 711.5.
5. HOLE BACKFILLED WITH CEMENT-BENTONITE GROUT.





NOTES:

1. WATER LEVEL DETERMINED AFTER 90 MINUTES WITH:
   BOTTOM OF AUGER = EL. 690.7.
   BOTTOM OF HOLE = EL. 691.0
   AFTER SAMPLING TO EL. 685.7.
2. HSA SET TO 686.7. HOLE STABILIZED WITH BENTONITE DRILLING MUD BELOW EL. 686.7.
3. MUD LOSS BETWEEN LAND 5 G.P.M. BELOW EL. 686.7.
4. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

2

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER

CHASKA CREEK STAGE 4 — CHASKA, MINNESOTA

BORING LOGS

BORING LOGS 89-115M THRU 89-118M

ED-D: DESIGNED: / CHECKED: / DRAWN:

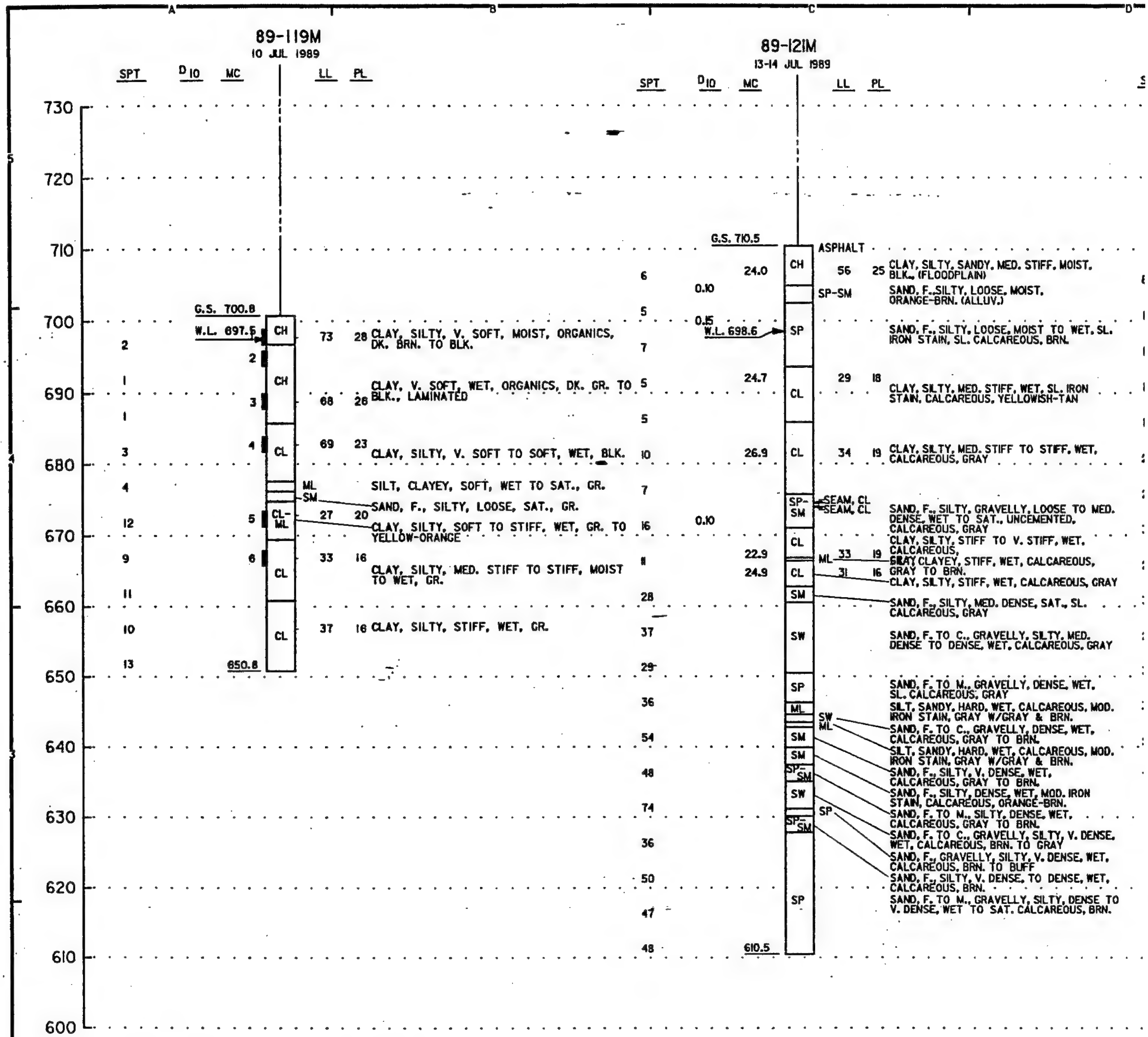
ED-GH: DESIGNED: JRC/PAW / CHECKED: JRC/DWM

DATE: 05-04-91

CAD FILE NAME: CHASKA10.DGN
SPEC NO: DACW37-90-B-0000

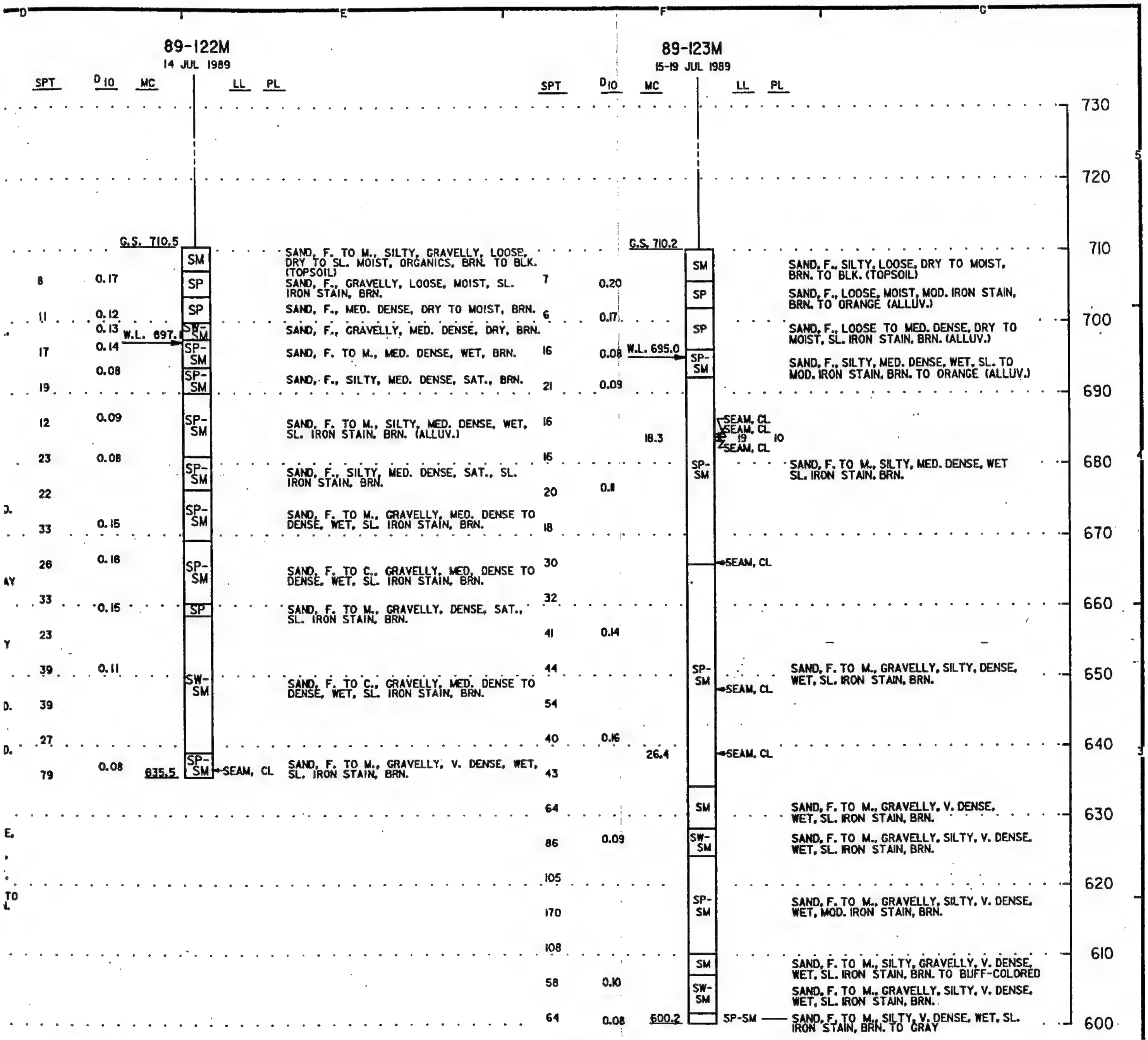
DRAWING NUMBER: PLATE C-12

SHT 12 OF 14



NOTES:

1. WATER LEVEL DETERMINED AFTER 2 HOURS WHEN:
   BOTTOM OF AUGER AT EL. 695.8.
   BOTTOM OF HOLE AT EL. 694.5.
   AFTER SAMPLING TO EL. 690.8.
2. HOLLOW STEM AUGER SET TO EL. 691.8. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 691.8.
3. WATER LOSS BELOW EL. 691.8 = 1 G.P.M.
4. SIX- 5" UNDISTURBED TUBE SAMPLES TAKEN IN AN OFFSET HOLE.
5. BOTH HOLES BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.



NOTES:

1. WATER LEVEL DETERMINED AFTER 14 HOURS WITH:
   BOTTOM OF AUGER AT EL. 695.5
   BOTTOM OF HOLE AT EL. 695.7
   AFTER SAMPLING TO EL. 690.5
2. HOLLOW STEM AUGER SET TO EL. 696.5. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 696.5.
3. MUD LOSS BELOW EL. 696.5 - 5 GPM.
4. HOLE BACKFILLED WITH TREMOID CEMENT-BENTONITE GROUT.

NOTES:

1. WATER LEVEL DETERMINED AFTER 2 HOURS WITH:
   BOTTOM OF AUGER AT EL. 690.2
   BOTTOM OF HOLE AT EL. 691.3
   AFTER SAMPLING TO EL. 685.2
2. HOLLOW STEM AUGER SET TO EL. 686.2. HOLE STABILIZED WITH DRILLING MUD BELOW 686.2.
3. WATER LOSS BELOW 686.2 = 1-4 GPM.
4. BACKFILLED HOLE WITH TREMED CEMENT-BENTONITE GROUT.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

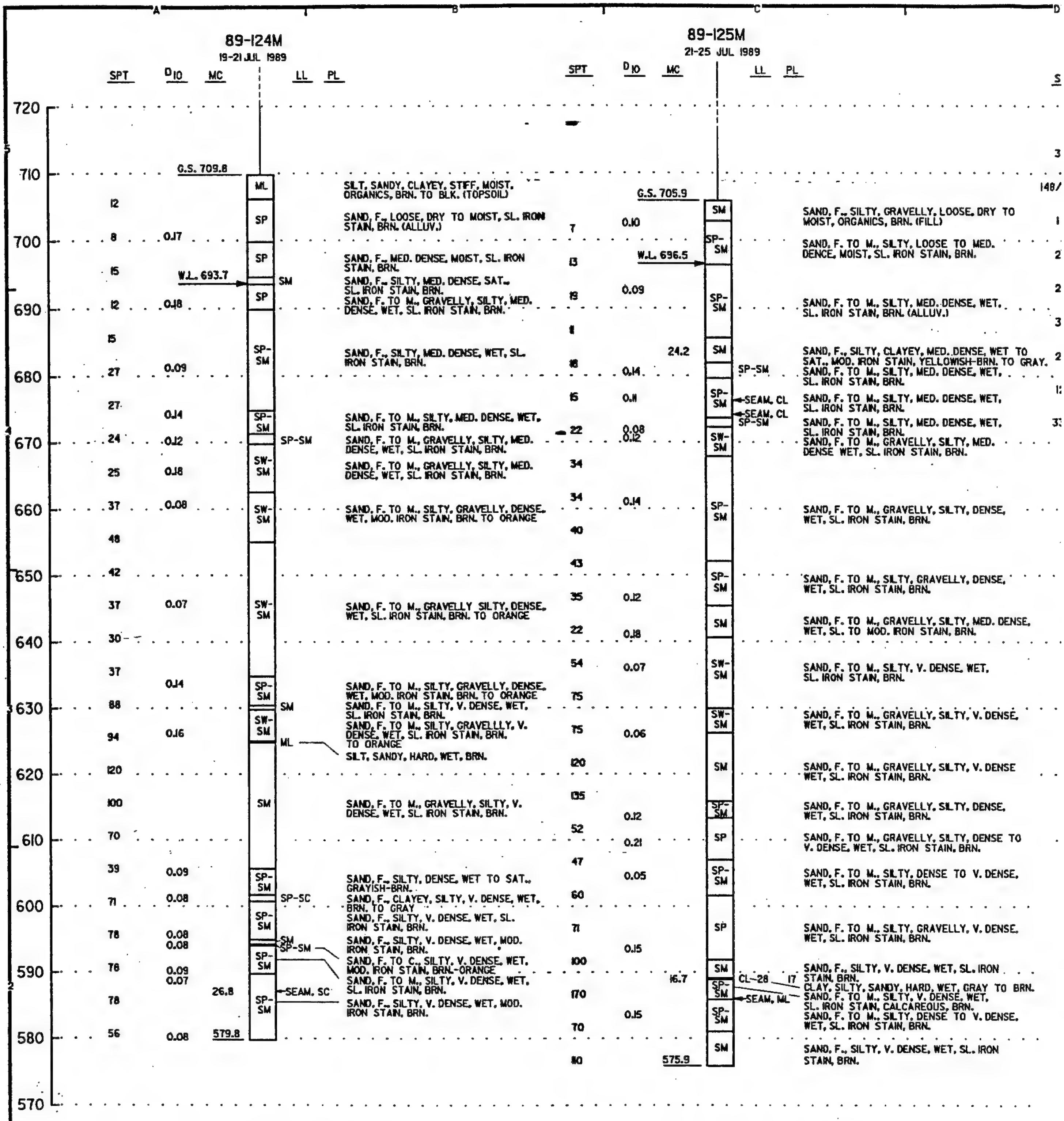
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA CREEK STAGE 4 CHASKA, MINNESOTA
BORING LOGS
BORING LOGS 89-119M, & 89-121M THRU 89-123M

ED-D	DESIGNED:	
	CHECKED:	
	DRAWN:	GRS
ED-GH	DESIGNED:	JRC/PAW
	CHECKED:	JRC/DWM

DATE: 05-04-91
CAD FILE NAME: CHASKA11.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE C-13
SHT 13 OF 14

2

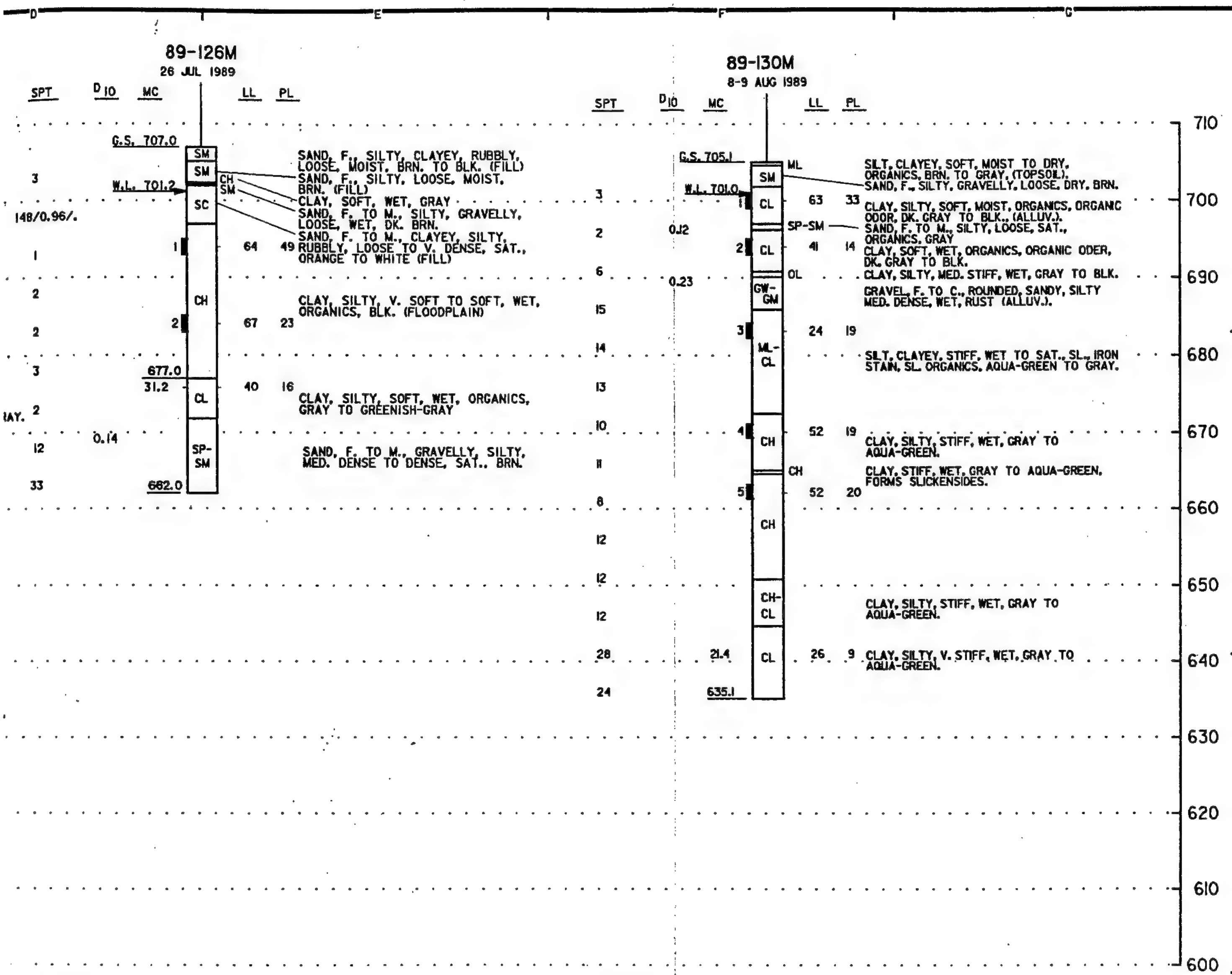


NOTES:

1. WATER LEVEL DETERMINED AFTER 1 HOUR WITH:
   BOTTOM OF AUGER AT EL. 694.8
   BOTTOM OF HOLE AT EL. 693.4
   AFTER SAMPLING TO 689.8
2. HOLLOW STEM AUGER SET TO EL. 690.8. HOLE STABILIZED WITH DRILLING MUD BELOW 690.8.
3. WATER LOSS BELOW 690.8 - 2-6 GPM; 20 GPM BETWEEN EL. 614.8 AND EL.613.8.
4. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

NOTES:

1. WATER LEVEL DETERMINED AFTER 90 MINUTES WITH:
   BOTTOM OF AUGER AT EL. 695.9
   BOTTOM OF HOLE AT EL. 696.1
   AFTER DRIVING SAMPLE TO EL. 690.9
2. HSA SET TO EL. 691.9. HOLE STABILIZED WITH DRILLING MUD BELOW 691.9.
3. WATER LOSS BELOW 691.9: 2-5 GPM.
4. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.



NOTES:

1. WATER LEVEL DETERMINED AFTER 40 MINUTES WITH:
   BOTTOM OF AUGER AT EL. 702.0
   BOTTOM OF HOLE AT EL. 700.4
   AFTER DRIVING SAMPLE TO EL. 697.6
2. HOLLOW STEM AUGER SET TO EL. 698.0. HOLE STABILIZED WITH DRILLING MUD BELOW 698.0.
3. WATER LOSS BELOW 698.0 = 1-3 GPM: 15-20 GPM BETWEEN 672.0 AND 667.0.
4. AN ADJACENT HOLE WAS DRILLED TO CONTINUE THE INITIAL HOLE FROM 677.0 TO 662.0. FROM THIS HOLE, 2 UNDISTURBED TUBE SAMPLES WERE TAKEN AT EL. 695.0 AND AT EL.685.0.
5. BOTH HOLES BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.
6. SMALL PIECES OF DEFORMED IRON RECOVERED IN STD. BARREL BARRELL

NOTES:

1. WATER LEVEL DETERMINED AFTER 75 MINUTES WITH:
   BOTTOM OF AUGER AT EL. 700.1.
   BOTTOM OF HOLE AT EL. 699.9.
   AFTER SAMPLING TO EL. 695.1.
2. HOLLOW STEM AUGER SET TO EL. 696.1. HOLE STABILIZED WITH DRILLING MUD BETWEEN 696.1 AND 680.1. WATER LOSS BETWEEN 1 AND 2 GPM. HOLLOW STEM AUGER RESET TO EL. 686.1. HOLE STABILIZED WITH DRILLING MUD BELOW 686.1. WATER LOSS 1-2 GPM.
3. 5-5 INCH UNDISTURBED SAMPLES TAKEN FROM AN ADJACENT HOLE.
4. BACKFILLED BOTH HOLES WITH TREMED CEMENT - BENTONITE GROUT.

SYMBOL	DESCRIPTION	DATE	APPROVAL

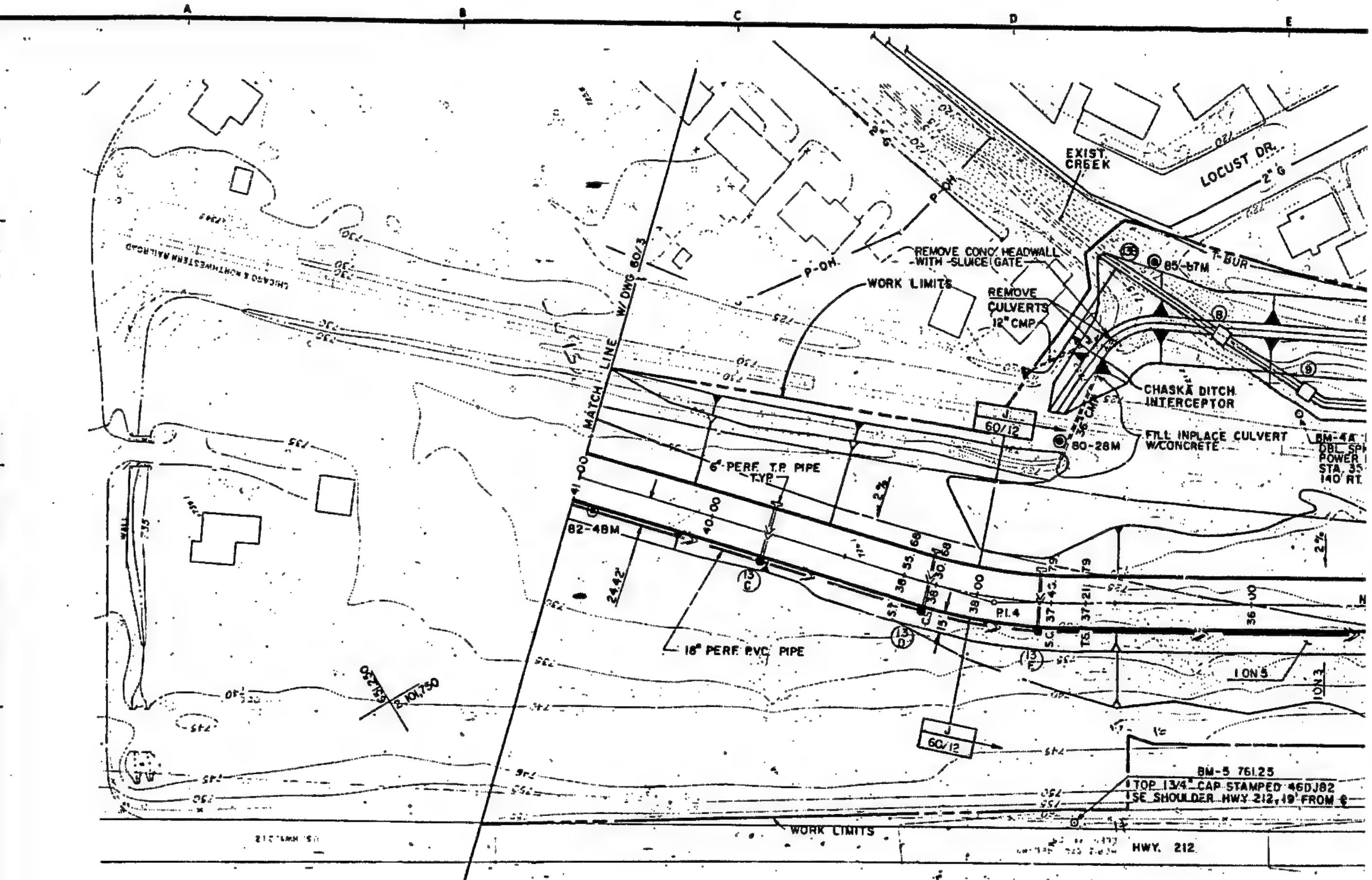
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

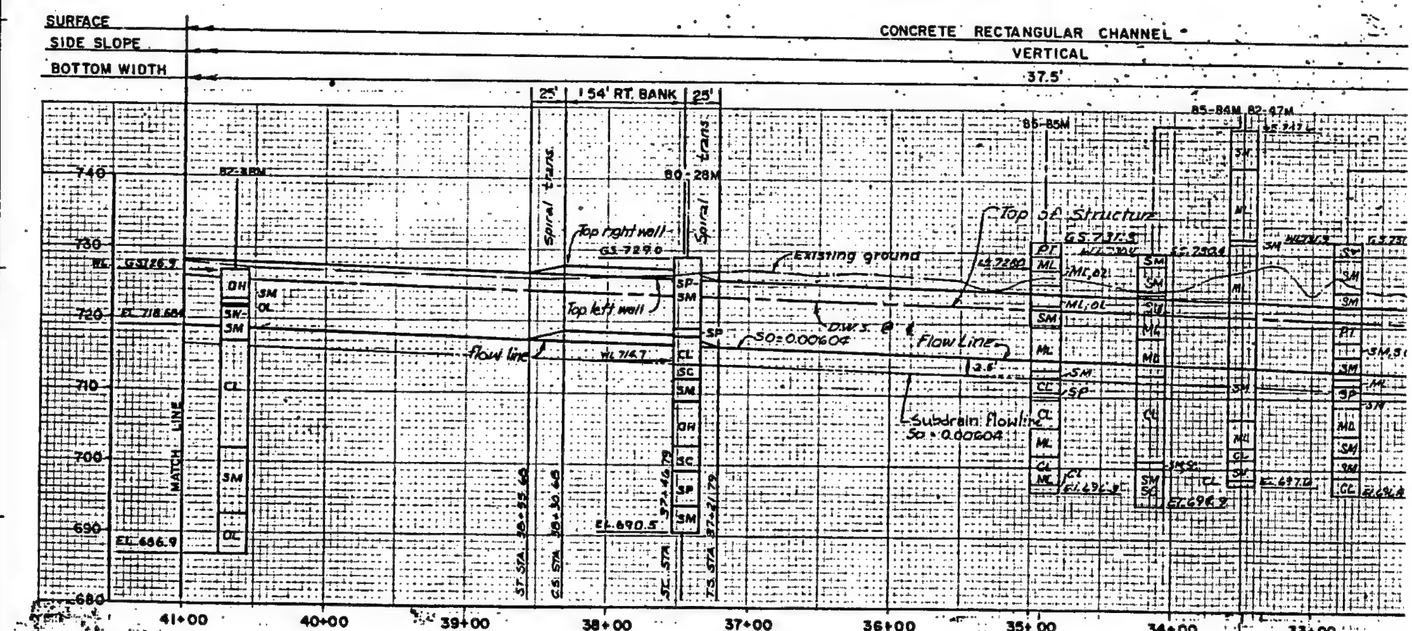
AE APPROVING OFFICIAL:

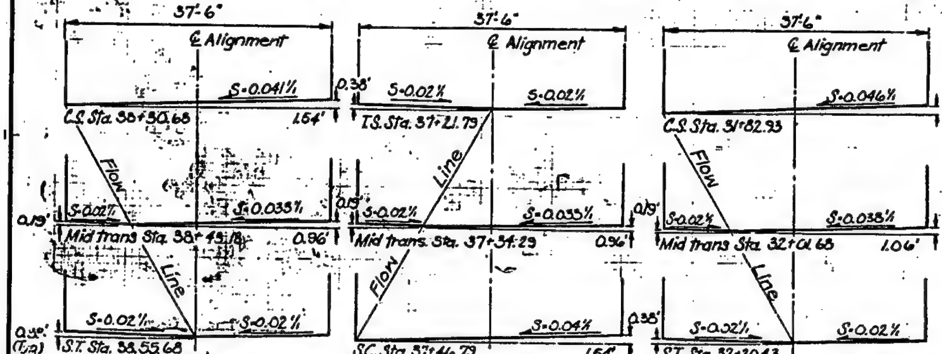
DESIGN MEMORANDUM NO. 2
CHASKA STAGE 4
FLOOD CONTROL - MINNESOTA RIVER
CHASKA CREEK STAGE 4 CHASKA, MINNESOTA
BORING LOGS
BORING LOGS 89-124M THRU 89-126M & 89-130M

ED-D: DESIGNED: / CHECKED: / DRAWN: GRS
ED-GH: DESIGNED: JRC/PAW / CHECKED: JRC/DWM
DATE: 05-04-91
CAD FILE NAME: CHASKA12.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE C-14
SHT 14 OF 14

2



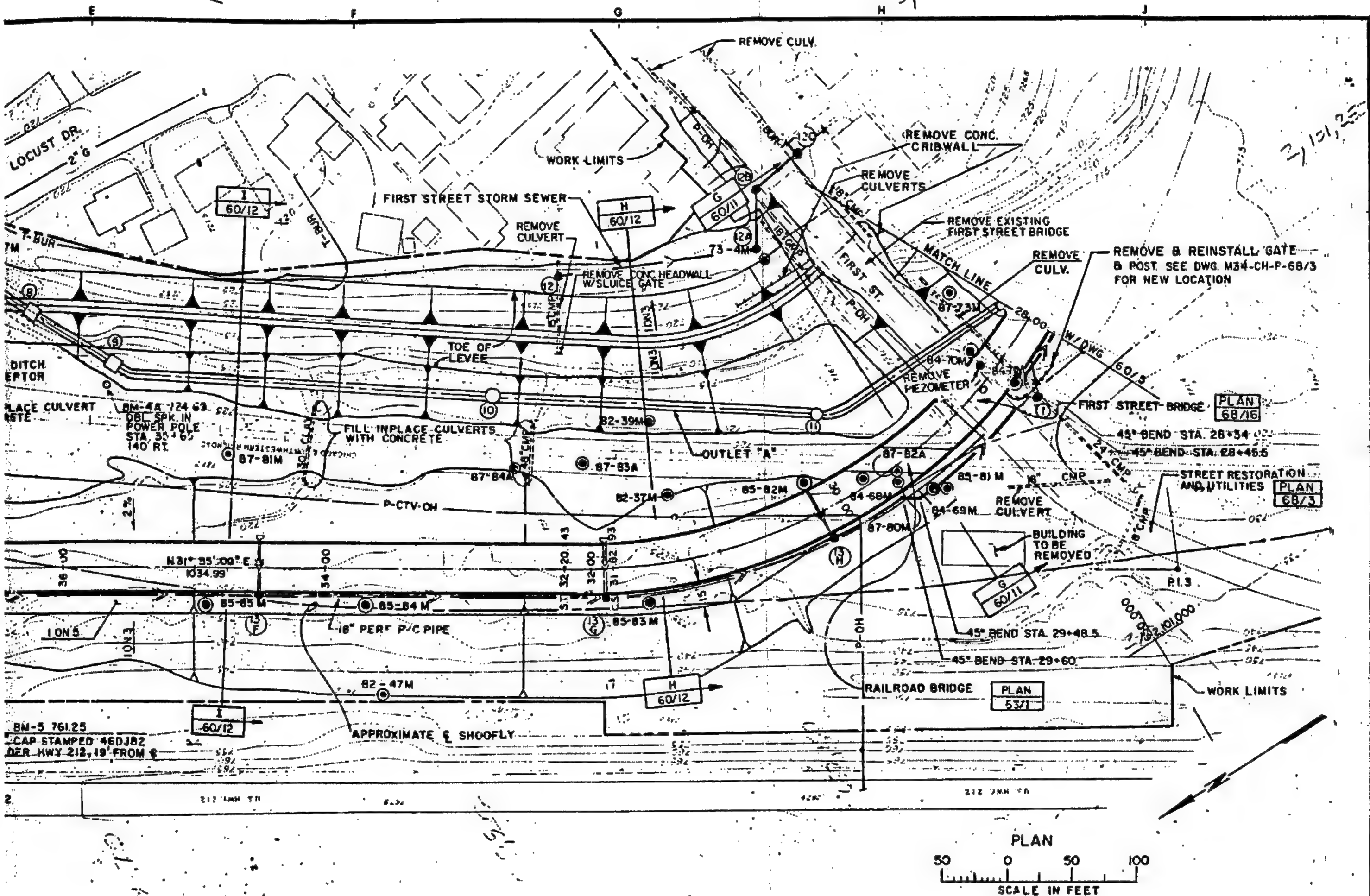


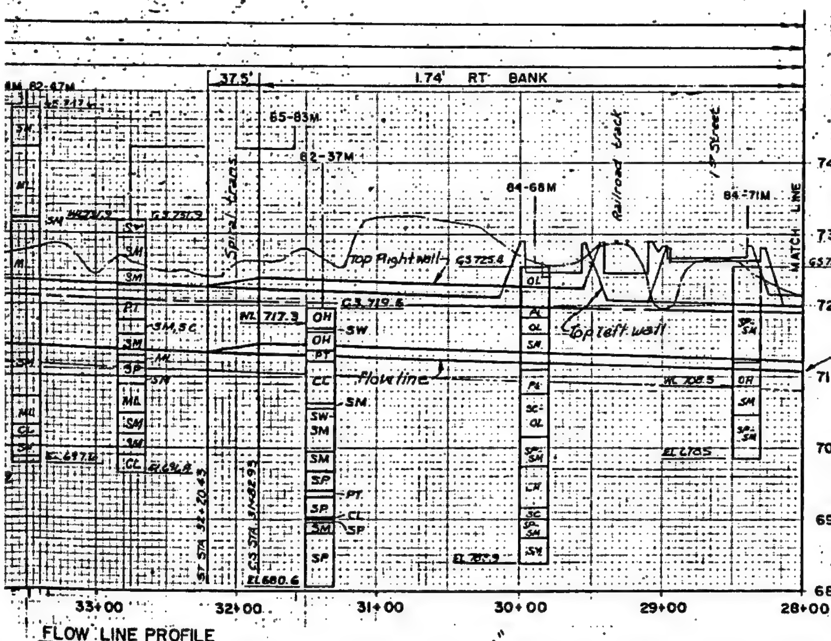


Superelevation transition
Scale 1"=10'

CHANNEL CONTROL

POINT	AZIMUTH	DISTANCE	N-COORD.	E-COORD.	P.I. STATION
P.I.-3			649,958.2374	2,101,036.3834	29+83.25
	31°55'00"	1034.985'			
P.I.-4			650,836.7512	2,101,583.5647	37+89.16
	47°54'50"	1290.158'			
P.I.-5			651,7014753	2,102,5410403	50+78.47





FLOW LINE PROFILE

Notes:

1. 6" perforated pipe to be placed 2'-3" behind railroad & First St bridge abutments Sta. 29+45 thru 28+45.5.

References:

1. For depth of cut below "in-service" RR Tracks, Dwg. M34-CH-P-66/11
2. For boring legend, Dwg. M34-CH-P-10/4
3. For detailed boring logs, Dwg. M34-CH-P-10/4 thru 10/9
4. For sheet pile placement, Dwg. M34-CH-P-34/19
5. For drainage profiles, Dwg. M34-CH-P-60/17
6. For drainage structure location and pipe size, Dwg. M34-CH-P-[illegible]
7. For levee details, Dwg. M34-CH-P-60/16
8. For outlet "A" plan & profile, Dwg. M34-CH-P-60/8
9. For First St. typical sections, Dwg. M34-CH-P-68/3
10. For Shoofly location, Dwg. M34-CH-P-66/11
11. For levee control alignment, Dwg. M34-CH-P-60/7
12. For subdrain & manhole details, Dwg. M34-CH-P-64/17
13. For First St. storm sewer, Dwg M34-CH-P-60/6, 60/7, 60/17.
14. For Chaska Ditch Interceptor, Dwg M34-CH-60/8 and 60/17.
15. For Plate Beam Guardrail, Dwg. M34-CH-P-64/21.
16. FOR STREET RESTORATION, DWG. M34-CH-P-68/3

92°19'26.85"
406.15'
628.43'

CHANNEL CONTROL LINE TRAVERSE

RD.	E-COORD.	PI STATION	Δ	ls	Δc	Tc	Rc	Lc	Ts	CL
2374	2,101,036.3834	29+83.25	97°50'00"	37.50'	91°44'11"	402.00'	390.00'	624.43'	466.25'	699.43'
7512	2,101,583.5647	37+89.16	15°59'50"	25'	12°19'28"	47.41'	390.00'	83.89'	67.37'	133.89'
1753	2,102,541.0403	50+78.47	46°25'50"	25'	42°56'13"	161.24'	410.00'	307.25'	188.40'	357.25'

SYMBOL	DESCRIPTION	DATE	APPROVAL

BRW
BENNETT, RINGROSE, WOLSFELD, JARVIS, GARDNER, INC.
MINNEAPOLIS, MINNESOTA

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

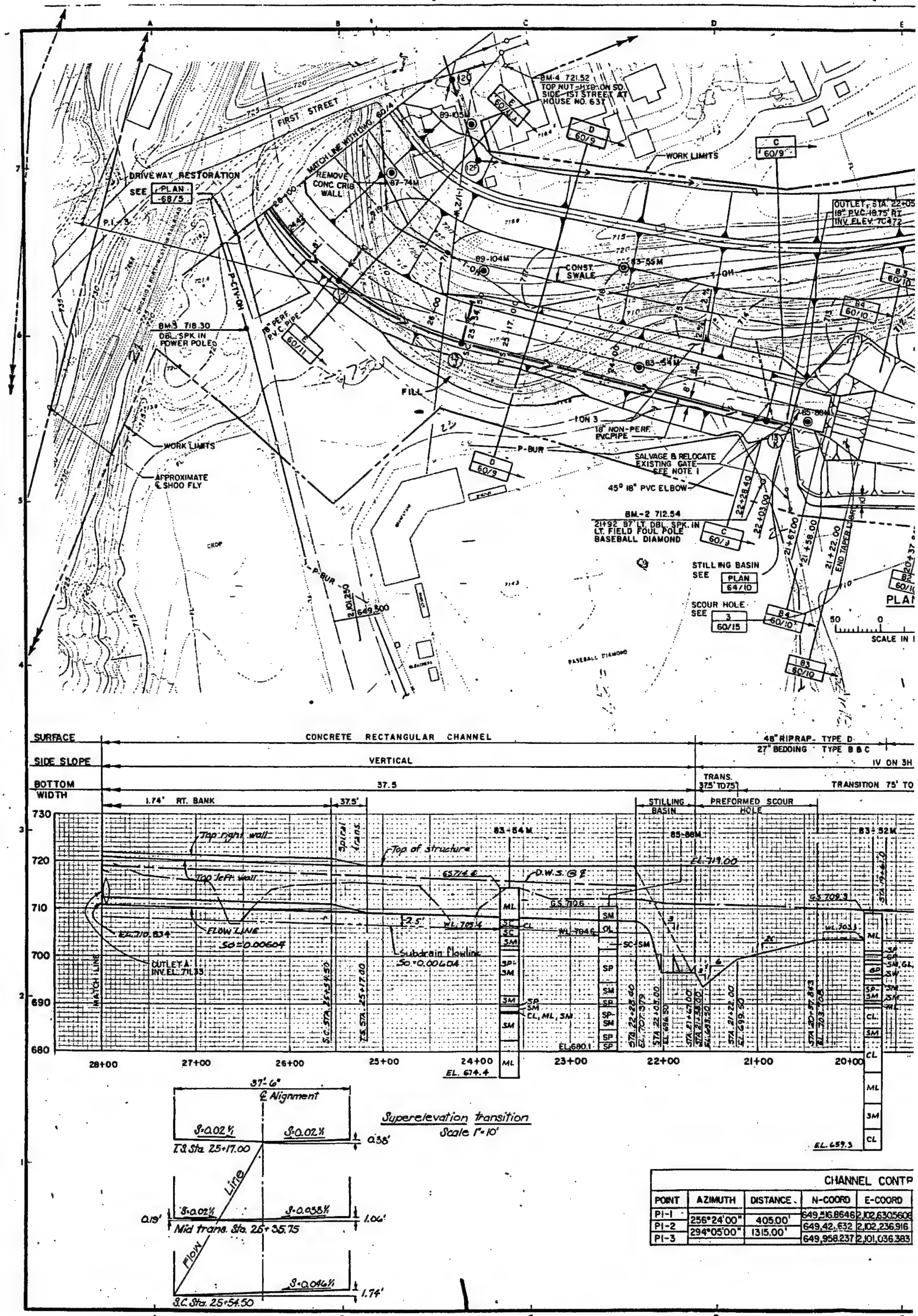
DESIGNED BY: T.J.S.
DRAWN BY: T.S.
CHECKED BY: SJF
SUBMITTED BY:

FLOOD CONTROL — MINNESOTA RIVER
CHASKA, MINNESOTA
CHASKA CREEK STAGE 2
MAIN CHANNEL PLAN & PROFILE
STA. 41+00 TO 28+00

APPROVED:
DATE: MAY 1989
SCALE: AS SHOWN
SPEC NO. DACW37-89-B-0020
DRAWING NUMBER
37-89-C-1004

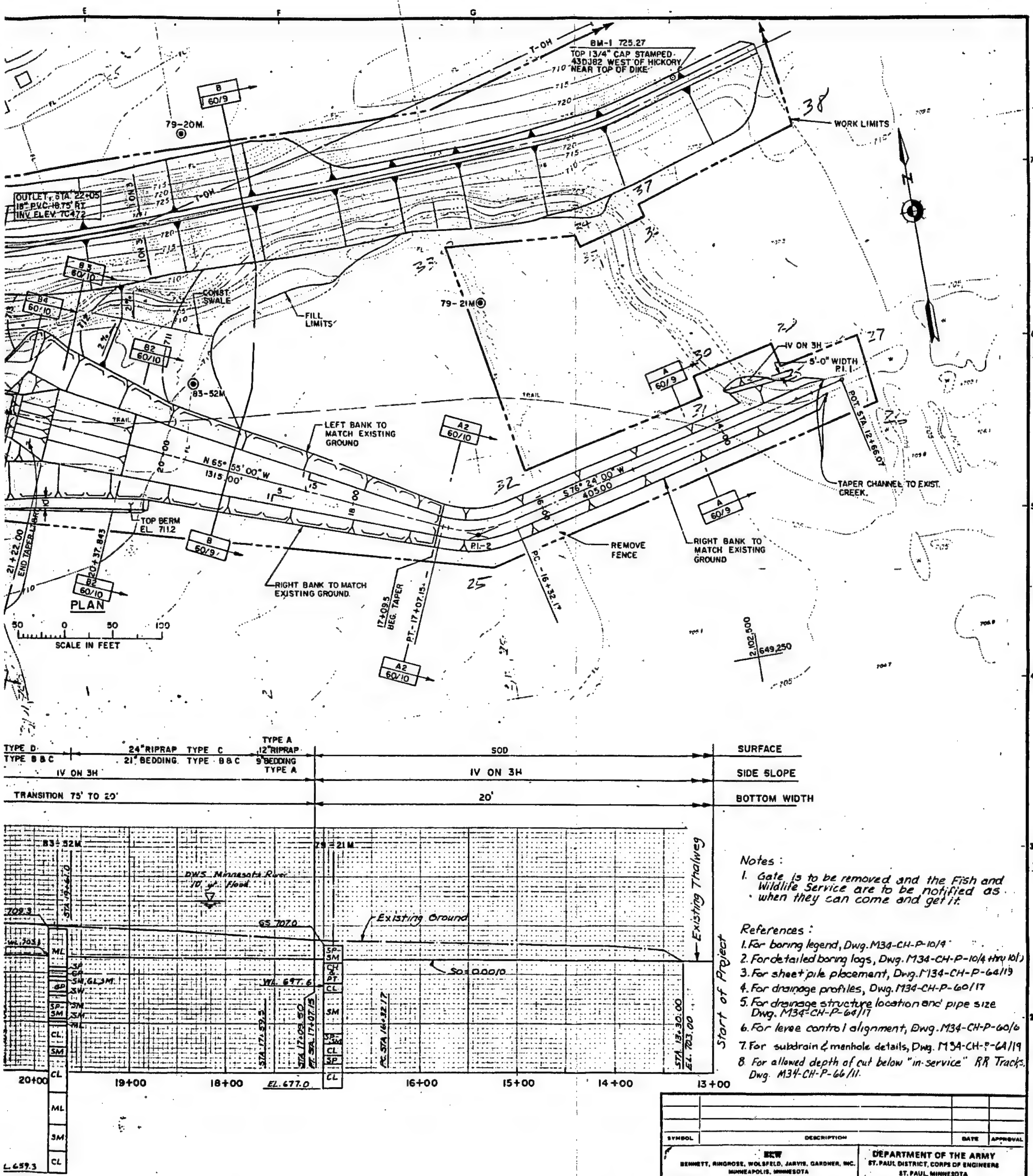
2

PLATE C-15



CHANNEL CONTP

POINT	AZIMUTH	DISTANCE	N-COORD	E-COORD
PI-1			649,516.8646	2,102,6305608
	256°24'00"	405.00'		
PI-2			649,42_.632	2,102,236.916
	294°05'00"	1315.00'		
PI-3			649,958.237	2,101,036.383



Notes :

1. Gate is to be removed and the Fish and Wildlife Service are to be notified as when they can come and get it.

References :

1. For boring legend, Dwg. M34-CH-P-10/4
2. For detailed boring logs, Dwg. M34-CH-P-10/4 thru 10/1
3. For sheet pile placement, Dwg. M34-CH-P-64/19
4. For drainage profiles, Dwg. M34-CH-P-60/17
5. For drainage structure location and pipe size Dwg. M34-CH-P-64/17
6. For levee control alignment, Dwg. M34-CH-P-60/6
7. For subdrain & manhole details, Dwg. M34-CH-P-64/19
8. For allowed depth of cut below "in-service" RR Tracks, Dwg. M34-CH-P-66/11.

CHANNEL CONTROL LINE TRAVERSE

-COORD	E-COORD	P.I. STATION	Δ	ℓ_s	Δ_c	T	R	L	T_s	CL
..16.8646	2,102,630.5606	12+66.07								
..42.632	2,102,236.916	16+71.07	37°41'00"			38.90'	114.00'	74.98'	—	—
..958.237	2,101,036.383	29+83.25	97°50'00"	37.50'	91°44'11"	402.00'	390.00'	624.43'	466.25'	699.43'

92°19' 26.85"
406.15'
628.43'

2

SYMBOL	DESCRIPTION	DATE	APPROVAL

BRW
BENNETT, RINGROSE, WOLSFELD, JARVIS, GARDNER, INC.
MINNEAPOLIS, MINNESOTA

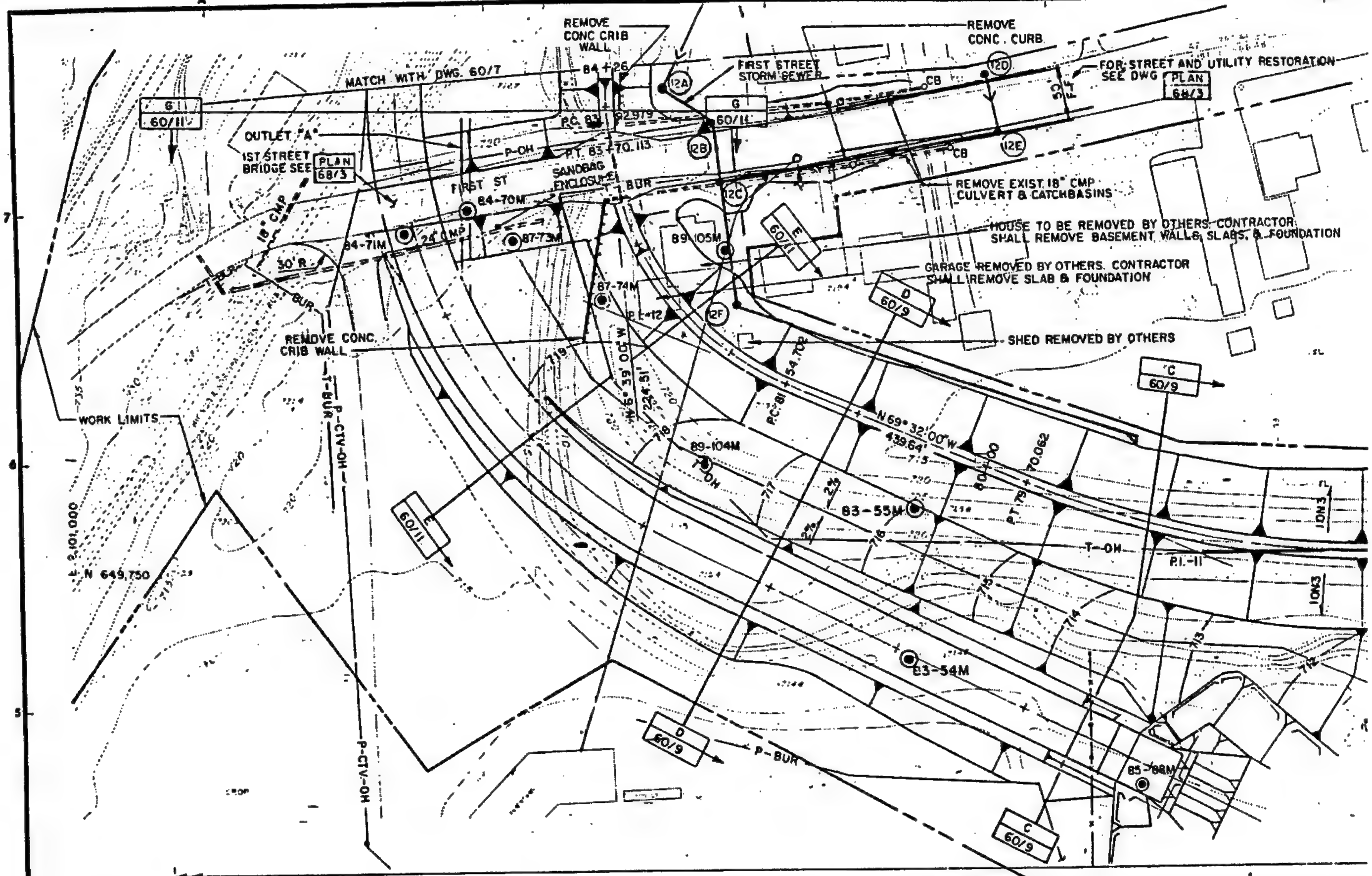
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

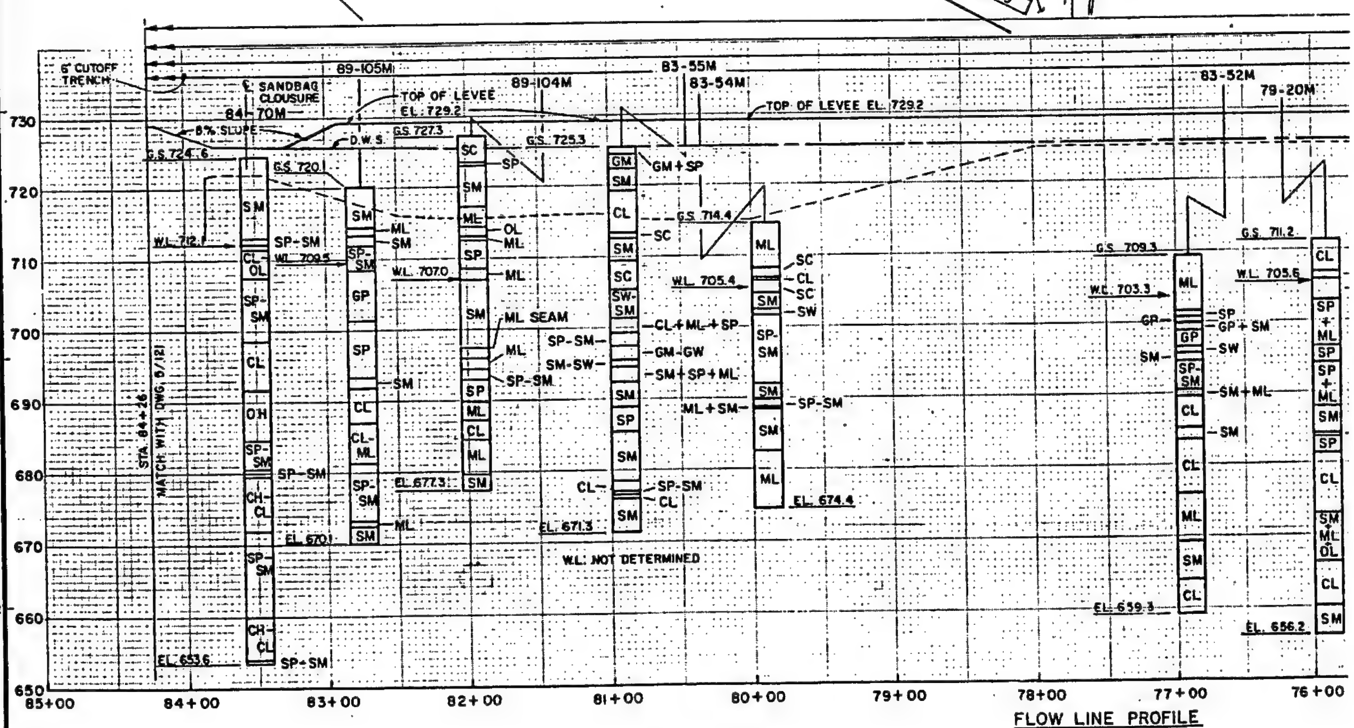
DESIGNED BY: T.J.S.
DRAWN BY: M.S.
CHECKED BY: GJE
SUBMITTED BY:
CHIEF ENG. BRANCH

FLOOD CONTROL — MINNESOTA RIVER
CHASKA, MINNESOTA
CHASKA CREEK STAGE 2
MAIN CHANNEL PLAN & PROFILE
STA. 28+00 TO 12+66

APPROVED:
CHIEF ED-GH BRANCH
CHIEF ENGR DIVISION
DATE: MAY 1989
SCALE: AS SHOWN
SPEC NO: DACW37-89-B-0020
DRAWING NUMBER: M34-CH-P-60/5
SHEET 15 OF 92

CONTRACT NO. DACW37-89-C-1004

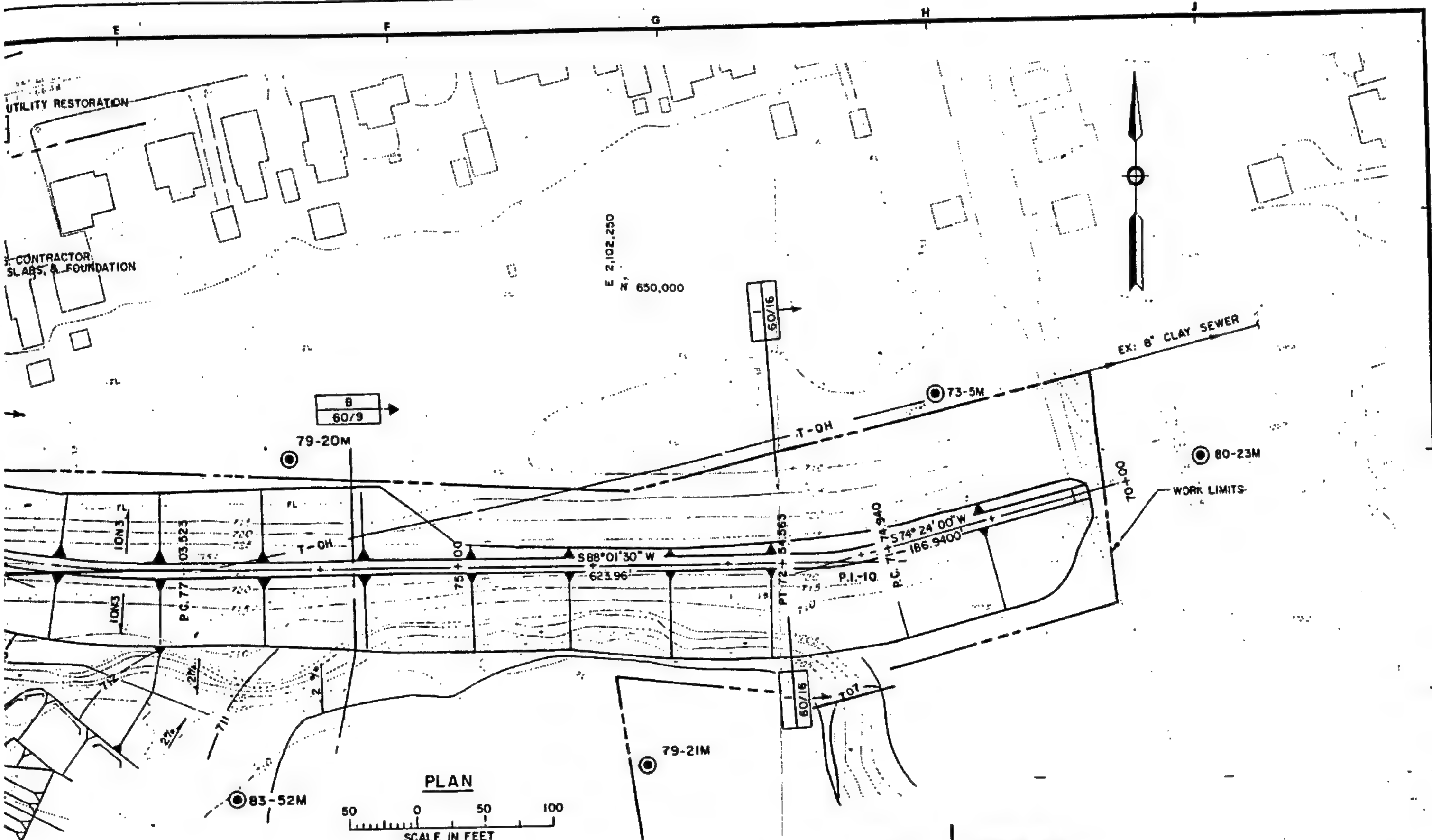


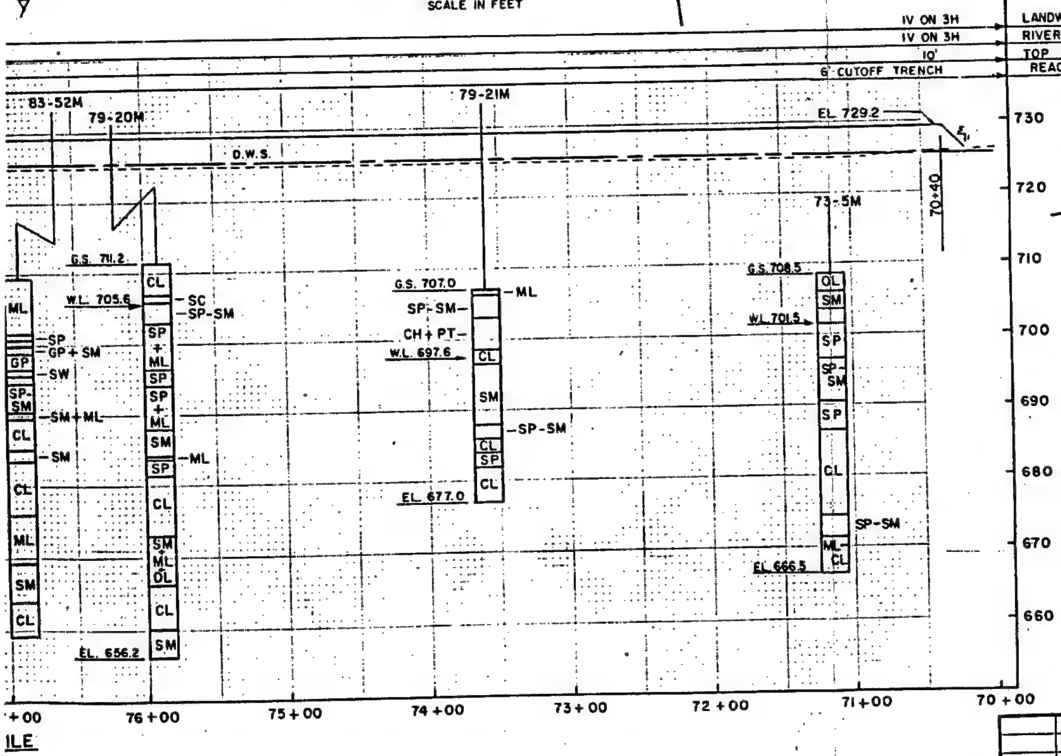


FLOW LINE PROFILE

LEVEE CON

POINT	AZIMUTH	DISTANCE	N-COORD.	E-COORD	P.I. ST
P.I.-10			649,810.860	2,102,418.691	72
P.I.-11	268°01'30"	623.96'	649,789.356	2,101,795.102	78
P.I.-12	290°28'00"	439.64'	649,943.082	2,101,383.214	82
P.I.-13					84





Notes:
1. Exist. conc. curb on First St. to be removed
2. Inspection trench this reach.
3. Exist. sewer and water services to house being removed are to be abandoned in an approved manner.
4. Construct 8" conc. driveway aprons on First St. to match existing driveways.

References:
1. For boring legend, Dwg. M34-CH-P-10/4
2. For detailed boring logs, Dwg. M34-CH-P-10/5 thru 10/8
3. For sheet pile placement, Dwg. M34-CH-P-64/19
4. For drainage profiles, Dwg. M34-CH-P-64/11
5. For drainage structure location and pipe size, Dwg. M34-CH-P-64/17
6. For First St. typical section, Dwg. M34-CH-P-68/3
7. For Cutoff and Inspection trench Chart, Dwg. M34-CH-P-60/17
8. For First Street Storm Sewer Profile, M34-CH-P-68/17
9. For Street Restoration, Dwg. M34-CH-P-68/3
10. For allowed depth of cut below "in-service" RR Tracks, Dwg. M34-CH-P-66/11

LEVEE CONTROL LINE TRAVERSE

N-COORD.	E-COORD	P.I. STATION	Δ	ℓ_c	Δ_c	T	R	L	Ts	CL
649,810.860	2,102,418.691	72+14.940	13°37'30"	—	—	40.00'	334.830'	79.623'	—	—
649,789.356	2,101,795.102	78+38.523	22°26'30"	—	—	135.00'	680.500'	266.539'	—	—
649,943.082	2,101,383.214	82+74.702	62°53'00"	—	—	120.00'	196.270'	215.411'	—	—
		84+74.623	42°05'15"	—	—	81.64'	212.207'	155.880'	—	—

SYMBOL	DESCRIPTION	DATE	APPROVAL

BRW
BENNETT, RINGROSE, WOLSFELD, JARVIS, GARDNER, INC.
MINNEAPOLIS, MINNESOTA

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: T.J.S.
DRAWN BY: H.S.
CHECKED BY: GJE
SUBMITTED BY:

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
CHASKA CREEK STAGE 2
LEVEE PLAN & PROFILE
STA. 70+28 TO 84+26

APPROVED:
CHIEF ENGR DIVISION
CHIEF ED-D BRANCH
CHIEF ED-GH BRANCH

DATE: MAY 1989
SCALE: AS SHOWN
SPEC. NO. DACW37-89-B-0020
DRAWING NUMBER M34-CH-P-60/6
SHEET 16 OF 92

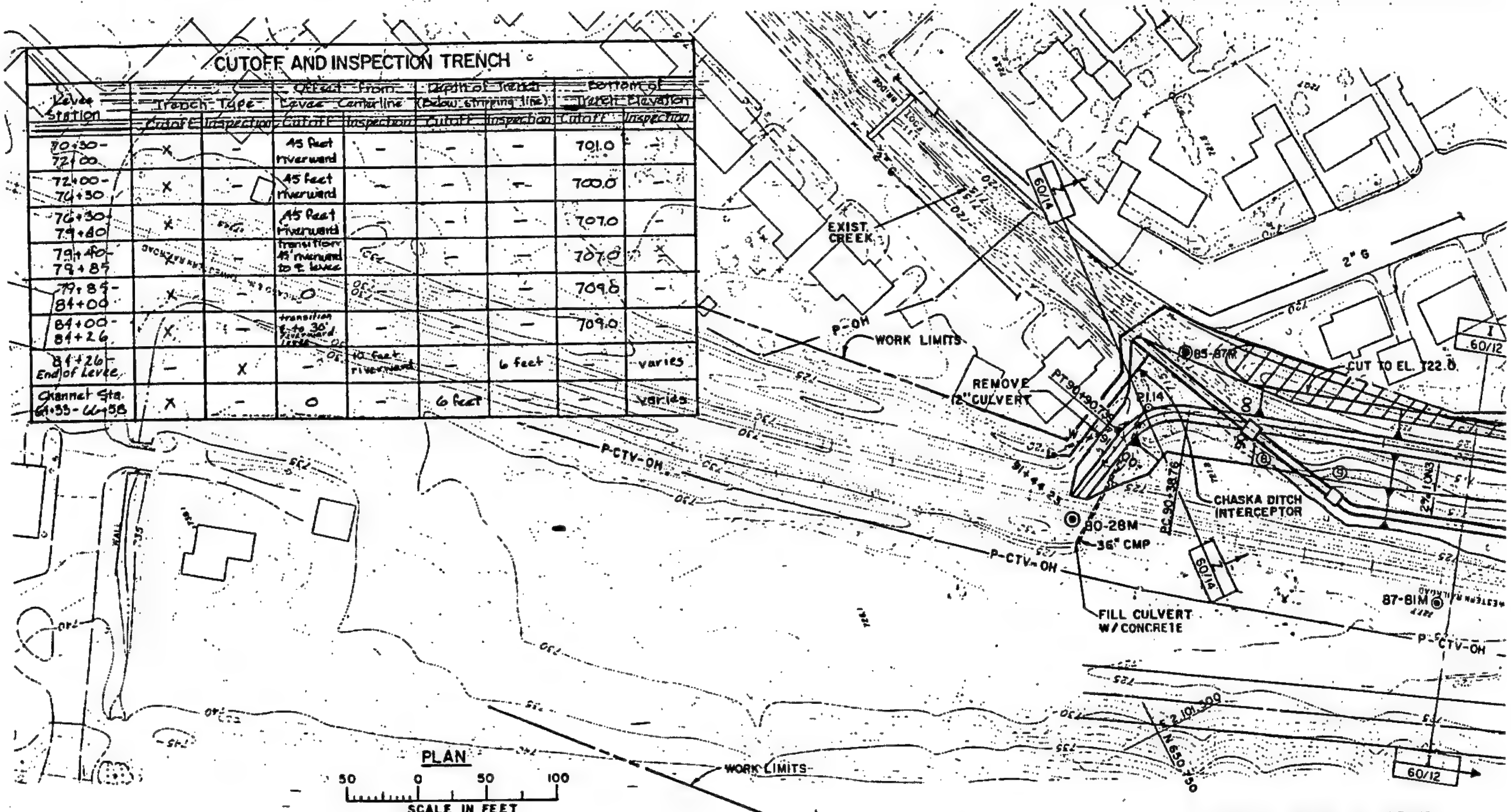
2

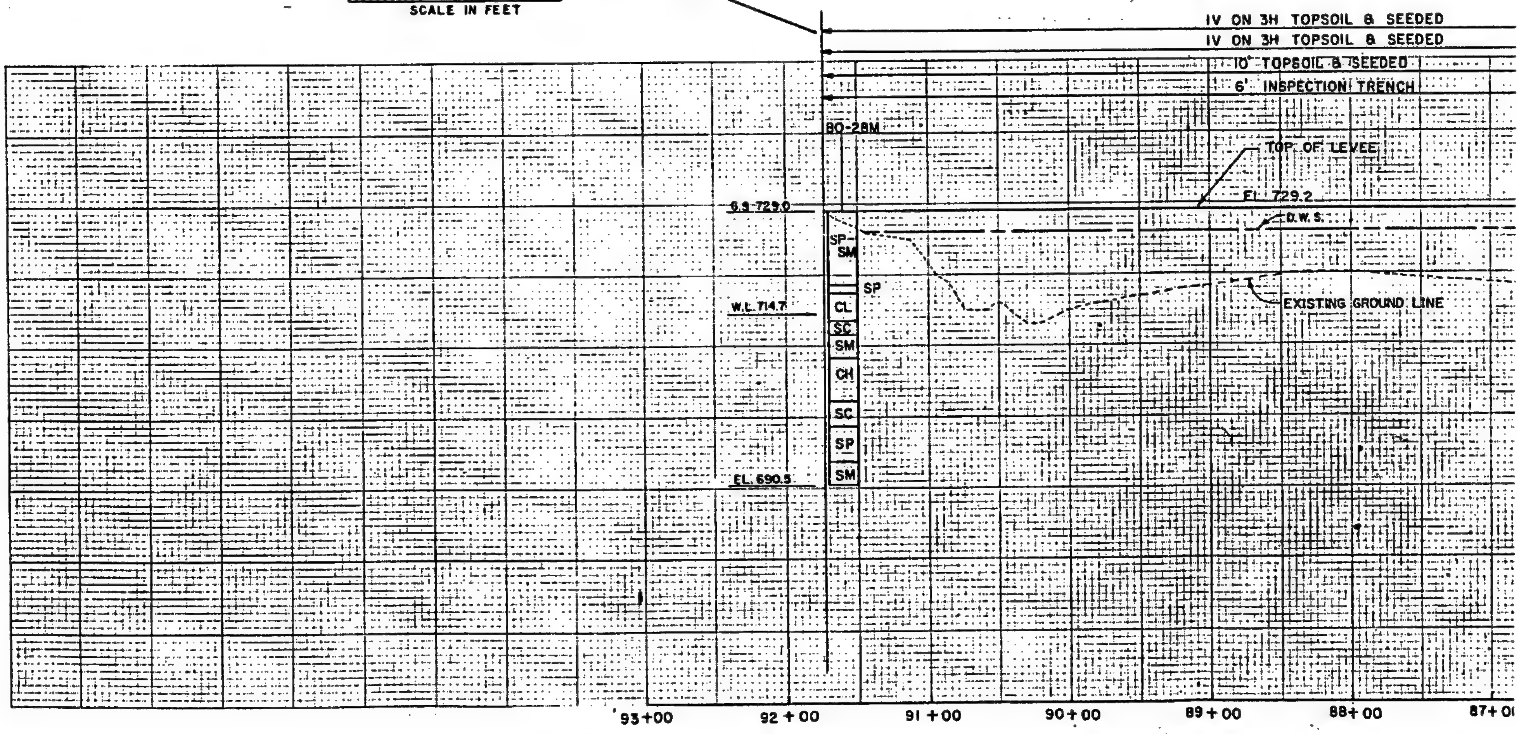
PLATE C-17

CONTRACT NO. DACW37-89-C-1004

CUTOFF AND INSPECTION TRENCH

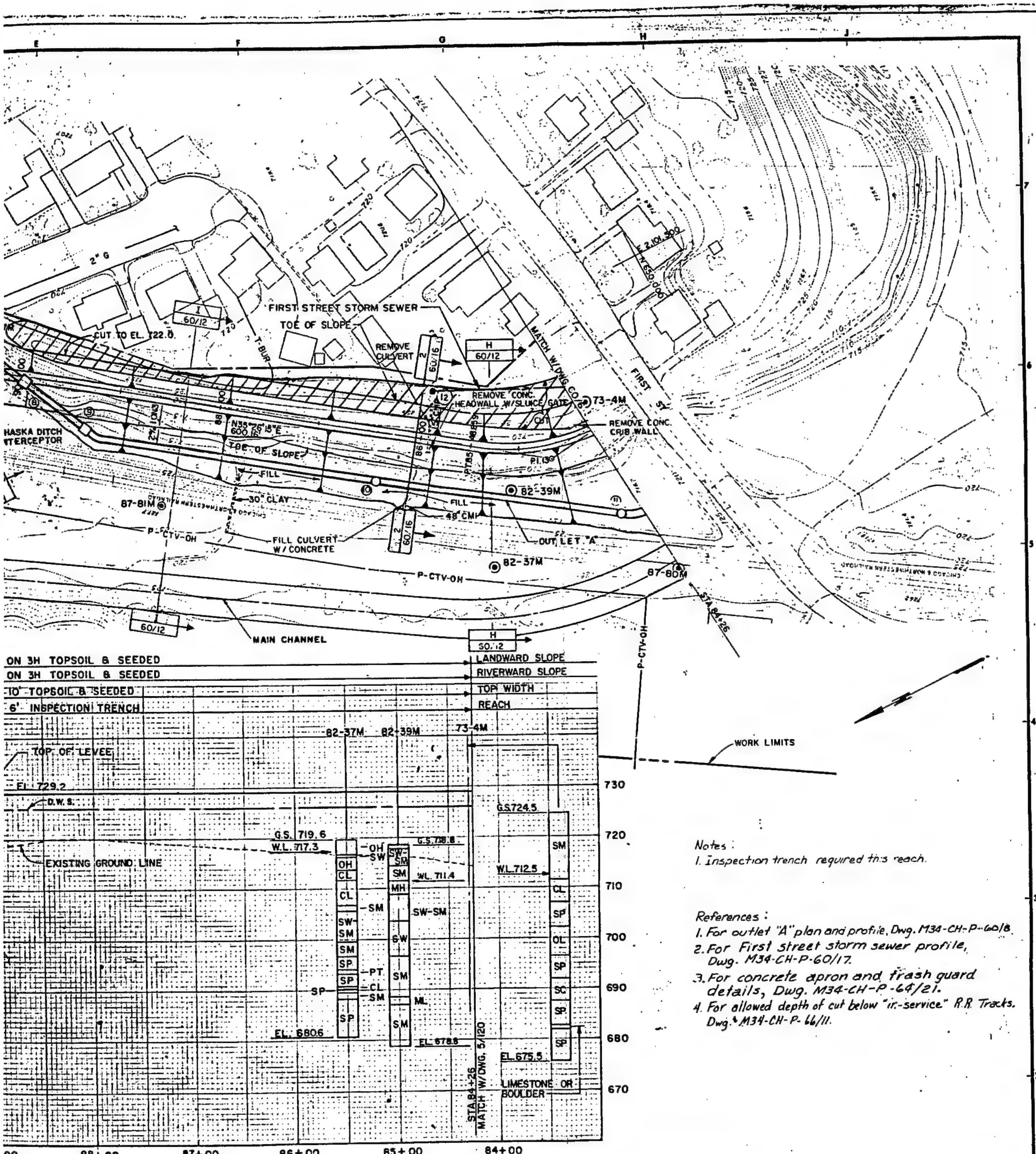
Levee Station	Trench Type		Offset from Levee Centerline		Depth of Trench (Below stripping line)		Bottom of Trench Elevation	
	Cutoff	Inspection	Cutoff	Inspection	Cutoff	Inspection	Cutoff	Inspection
70+30-72+00	X	–	45 feet riverward	–	–	–	701.0	–
72+00-76+30	X	–	45 feet riverward	–	–	–	700.0	–
76+30-79+40	X	–	45 feet riverward	–	–	–	707.0	–
79+40-79+85	X	–	transition 45' riverward to ℄ levee	–	–	–	707.0	X
79+85-84+00	X	–	0	–	–	–	709.0	–
84+00-84+26	X	–	transition ℄ to 30' riverward levee	–	–	–	709.0	–
84+26 End of Levee	–	X	–	10 feet riverward	–	6 feet	–	varies
Channel Sta. 64+33-66+58	X	–	0	–	6 feet	–	–	varies





LEVEE CONTROL LINE TRAV

POINT	AZIMUTH	DISTANCE	N-COORD.	E-COORD.	P.I. STATION	Δ	ℓs
P.I.-13			650,166.082	2,101,357.215	84+74.623	42°05'15"	
	35°26'15"	600.16'					
P.I.-14			650,655.061	2,101,705.197	90+67.375	59°33'45"	
	335°52'30"	82.10'					
END			650,729.990	2,101,671.640			



Notes:
1. Inspection trench required this reach.

References:
1. For outlet "A" plan and profile, Dwg. M34-CH-P-60/18.
2. For First Street storm sewer profile, Dwg. M34-CH-P-60/17.
3. For concrete apron and trash guard details, Dwg. M34-CH-P-64/21.
4. For allowed depth of cut below "in-service" R.R. Tracks. Dwg. M34-CH-P-66/11.

LEVEE CONTROL LINE TRAVERSE

	E-COORD.	P.I. STATION	Δ	ℓ_s	Δc	T	R	L	Tc	CL
22	2,101,357.215	84+74.623	42°05'15"			81.644'	212.2066	155.880'	—	
61	2,101,705.197	90+67.375	59°33'45"			28.614'	50.00'	51.978'	—	
10	2,101,671.640									

2

SYMBOL	DESCRIPTION	DATE	APPROVAL

BENNETT, RINGROSE, WOLSFELD, JARVIS, GARDNER, INC. MINNEAPOLIS, MINNESOTA

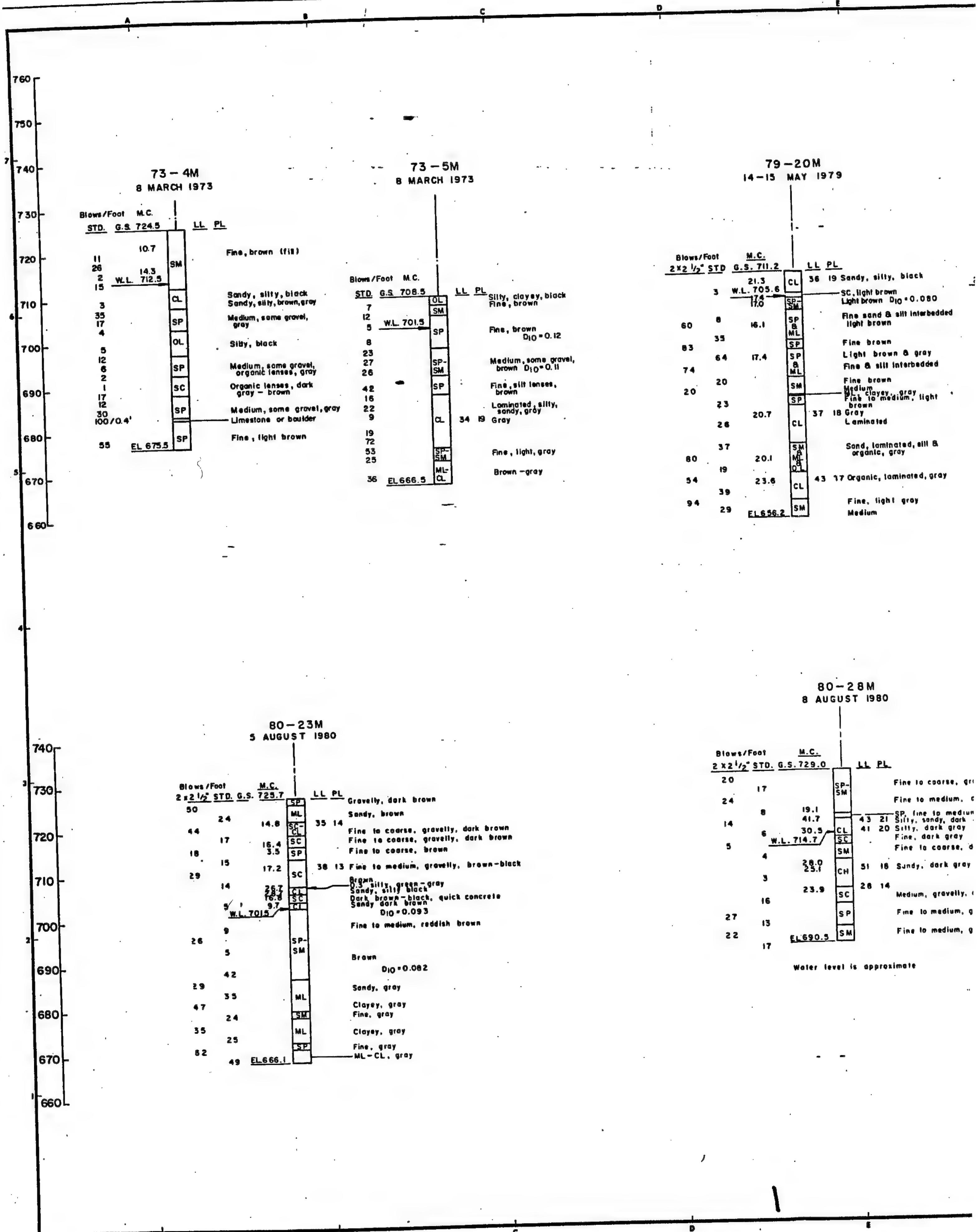
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: T.J.S.
DRAWN BY: H.S.
CHECKED BY: GJE
SUBMITTED BY:

FLOOD CONTROL — MINNESOTA RIVER
CHASKA, MINNESOTA
CHASKA CREEK STAGE 2
LEVEE PLAN & PROFILE
STA. 84+26 TO 91+73

APPROVED:
CHIEF ENGR. DIVISION
DATE: MAY 1989
SCALE: AS SHOWN
SPEC. NO. DACW37-89-B-0020
DRAWING NUMBER M34-CH-P-60/17
SHEET 17 OF 92

CONTRACT NO. DACW37-89-C-1004



73 – 4M
8 MARCH 1973
Blows/Foot STD.
M.C. G.S. 724.5
LL PL
W.L. 712.5
EL 675.5
Fine, brown (fill)
Sandy, silty, black
Sandy, silty, brown, gray
Medium, some gravel, gray
Silty, black
Medium, some gravel, organic lenses, gray
Organic lenses, dark gray – brown
Medium, some gravel, gray
Limestone or boulder
Fine, light brown
73 – 5M
8 MARCH 1973
Blows/Foot STD.
M.C. G.S. 708.5
LL PL
W.L. 701.5
EL 666.5
Silty, clayey, black
Fine, brown
Fine, brown
D10 = 0.12
Medium, some gravel, brown D10 = 0.11
Fine, silt lenses, brown
Laminated, silty, sandy, gray
Gray
Fine, light, gray
Brown – gray
79 – 20M
14 – 15 MAY 1979
Blows/Foot 2×2 1/2" STD
M.C. G.S. 711.2
LL PL
W.L. 705.6
EL 656.2
Sandy, silty, black
SC, light brown
Light brown D10 = 0.080
Fine sand & silt interbedded light brown
Fine brown
Light brown & gray
Fine & silt interbedded
Fine brown
Medium
ML, clayey, gray
Fine to medium, light brown
Gray
Laminated
Sand, laminated, silt & organic, gray
Organic, laminated, gray
Fine, light gray
Medium
80 – 23M
5 AUGUST 1980
Blows/Foot 2×2 1/2" STD.
M.C. G.S. 725.7
LL PL
W.L. 701.5
EL 666.1
Gravelly, dark brown
Sandy, brown
Fine to coarse, gravelly, dark brown
Fine to coarse, gravelly, dark brown
Fine to coarse, brown
Fine to medium, gravelly, brown-black
Brown
O.S. silty, green – gray
Sandy, silty black
Dark brown – black, quick concrete
Sandy dark brown
D10 = 0.093
Fine to medium, reddish brown
Brown
D10 = 0.082
Sandy, gray
Clayey, gray
Fine, gray
Clayey, gray
Fine, gray
ML – CL, gray
80 – 28M
8 AUGUST 1980
Blows/Foot 2×2 1/2" STD.
M.C. G.S. 729.0
LL PL
W.L. 714.7
EL 690.5
Fine to coarse, gr
Fine to medium, c
SP, fine to medium
Silty, sandy, dark
Silty, dark gray
Fine, dark gray
Fine to coarse, d
Sandy, dark gray
Medium, gravelly,
Fine to medium, g
Fine to medium, g
Water level is approximate

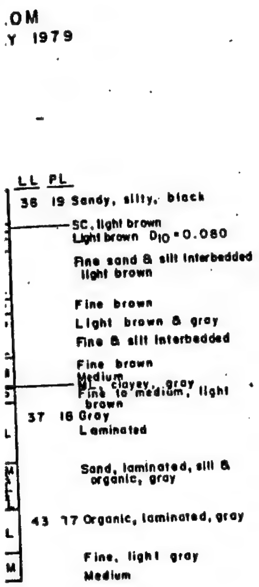
GENERAL BORING LEGEND

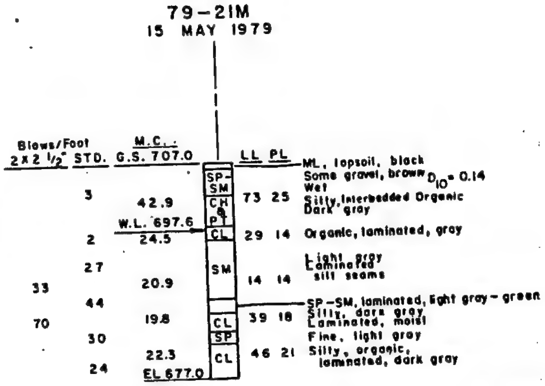
84–1M	YEAR OF BORING–BORING NUMBER, BORING TYPE (EG: M=MACHINE, A=AUGER, TP=TEST PIT, P=PIEZOMETER).
1 MAY 1984	DATE OF BORING
G.S. 1020.2	GROUND SURFACE ELEVATION AT BORING
GW	WELL GRADED GRAVELS, GRAVEL – SAND MIXTURE, LITTLE OR NO FINES
GP	POORLY GRADED GRAVELS, LITTLE OR NO FINES
GM	SILTY GRAVELS, GRAVEL – SAND – SILT MIXTURES
GC	CLAYEY GRAVELS, GRAVEL – SAND – CLAY MIXTURES
SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SM	SILTY SANDS, SAND – SILT MIXTURES
SC	CLAYEY SANDS, SAND – CLAY MIXTURES
ML	INORGANIC SILTS, LIQUID LIMIT LESS THAN 50
MH	INORGANIC SILTS, LIQUID LIMIT GREATER THAN 50
CL	INORGANIC CLAYS, LOW TO MEDIUM PLASTICITY, LIQUID LIMIT LESS THAN 50
CH	INORGANIC CLAYS, HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
OL	ORGANIC SILTS OR CLAYS, LOW PLASTICITY, LIQUID LIMIT LESS THAN 50
OH	ORGANIC SILTS OR CLAYS, MEDIUM TO HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
PT	PEAT
SP-SM	BORDERLINE MATERIAL
SP& SM	STRATIFIED MATERIAL
	LOCATION AND SAMPLE NUMBER FOR UNDISTURBED SAMPLE
	NO RECOVERY
W.L. 726.7	WATER LEVEL ON DATE OF BORING
700	ELEVATION AT BOTTOM OF BORING

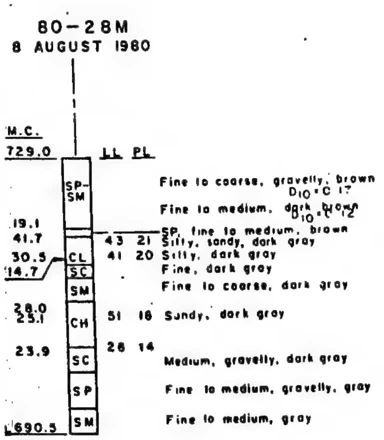
GENERAL BORING NOTES

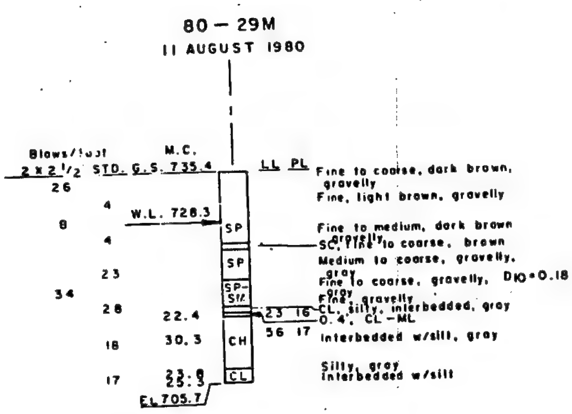
1. GENERAL: THE UNIFIED SOIL CLASSIFICATION SYSTEM IS USED TO IDENTIFY BASIC SOIL TYPE. THE LEGEND REPRESENTS ONLY THE BASIC SOILS. TO COMPLETE THE CLASSIFICATION, PERTINENT INFORMATION IS ADDED TO THE RIGHT OF THE BORING STAFF. NOTES PERTAINING TO A SPECIFIC BORING ARE SHOWN BELOW THE BORING STAFF.
2. MOISTURE CONTENT: THE NATURAL MOISTURE CONTENT IN PERCENT OF DRY WEIGHT (MC) IS SHOWN TO THE LEFT OF THE BORING STAFF.
3. BLOW COUNT (SPT): BLOW COUNTS ARE SHOWN TO THE LEFT OF THE BORING STAFF AND, EXCEPT AS NOTED, ARE THE NUMBER OF BLOWS NECESSARY TO DRIVE THE SAMPLER USED A DISTANCE OF 12". STANDARD BLOW COUNTS ARE FOR A STANDARD PENETRATION TEST (SPT) USING A 1-3/8" X 2" SAMPLER, 140 LB. HAMMER AND A 30" DROP. FOR NON-STANDARD BLOW COUNTS, SAMPLER SIZE, HAMMER WEIGHT AND HEIGHT OF DROP ARE AS SHOWN.
4. ATTERBERG LIMITS: LIQUID LIMIT (LL) AND PLASTIC LIMIT (PL) ARE SHOWN TO THE RIGHT OF THE BORING STAFF.
5. D_{10} SIZE: THE GRAIN SIZE IN MILLIMETERS OF WHICH 10% OF THE SAMPLE IS FINER IS SHOWN TO THE LEFT OF THE BORING STAFF.

W.H.- WEIGHT HAMMER (PENETRATION ACHIEVED BY WEIGHT OF HAMMER ALONE.)









Water level is approximate

SYMBOL	DESCRIPTION	DATE	APPROVAL

BRW
BENNETT, RINGROSE, WOLSFELD, JARVIS, GARDNER, INC.
MINNEAPOLIS, MINNESOTA

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: PDM
DRAWN BY: GAO
CHECKED BY: LHB
SUBMITTED BY:

FLOOD CONTROL — MINNESOTA RIVER
CHASKA, MINNESOTA
CHASKA CREEK STAGE 2
BORING LOGS
73-4M THRU 80-29M

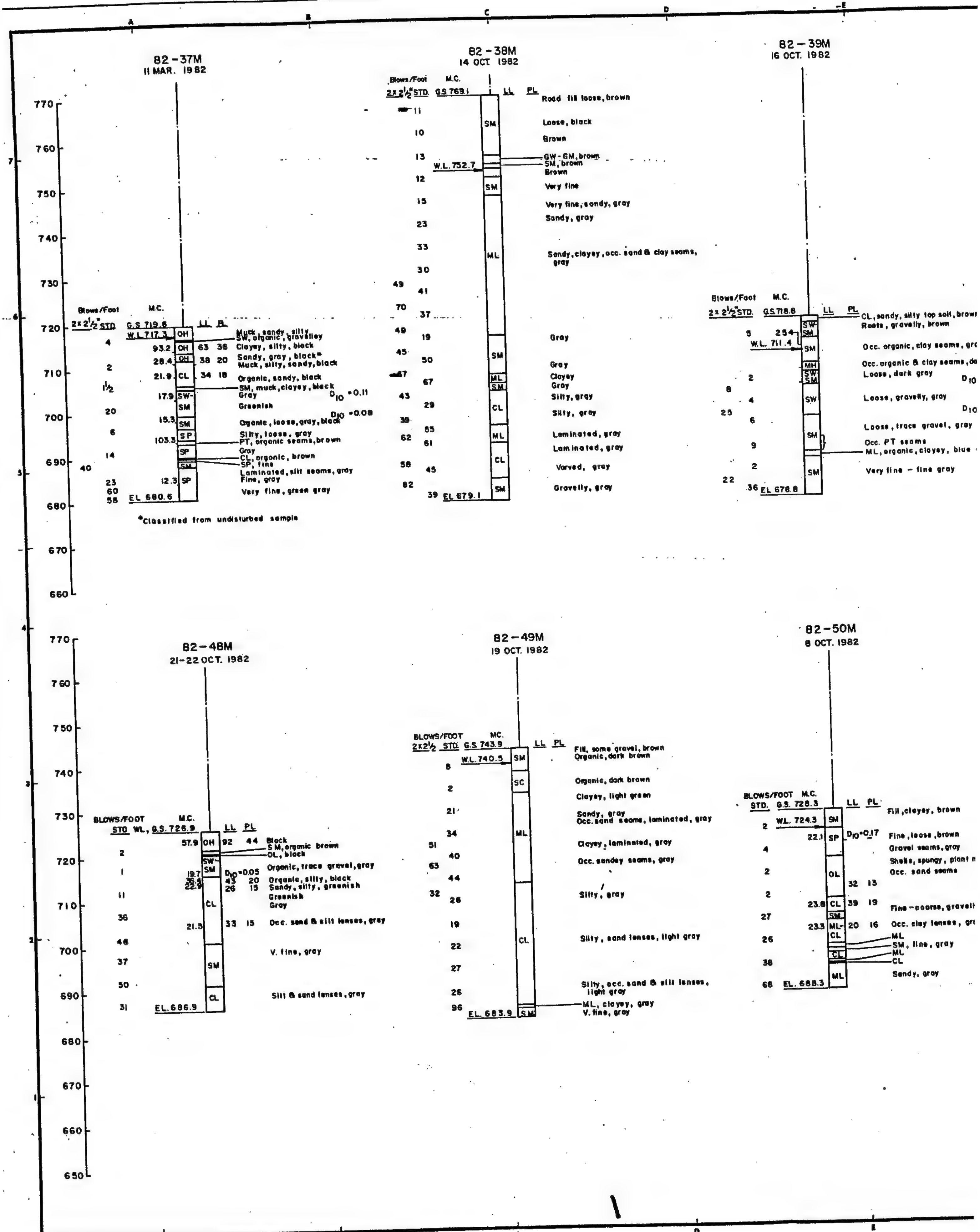
APPROVED:
DATE: MAY 1989
SCALE: AS SHOWN
SPEC. NO. DACW37-89-B-0020
DRAWING NUMBER M34-CH-P-10/4
SHEET 4 OF 92

SAFETY PAYS

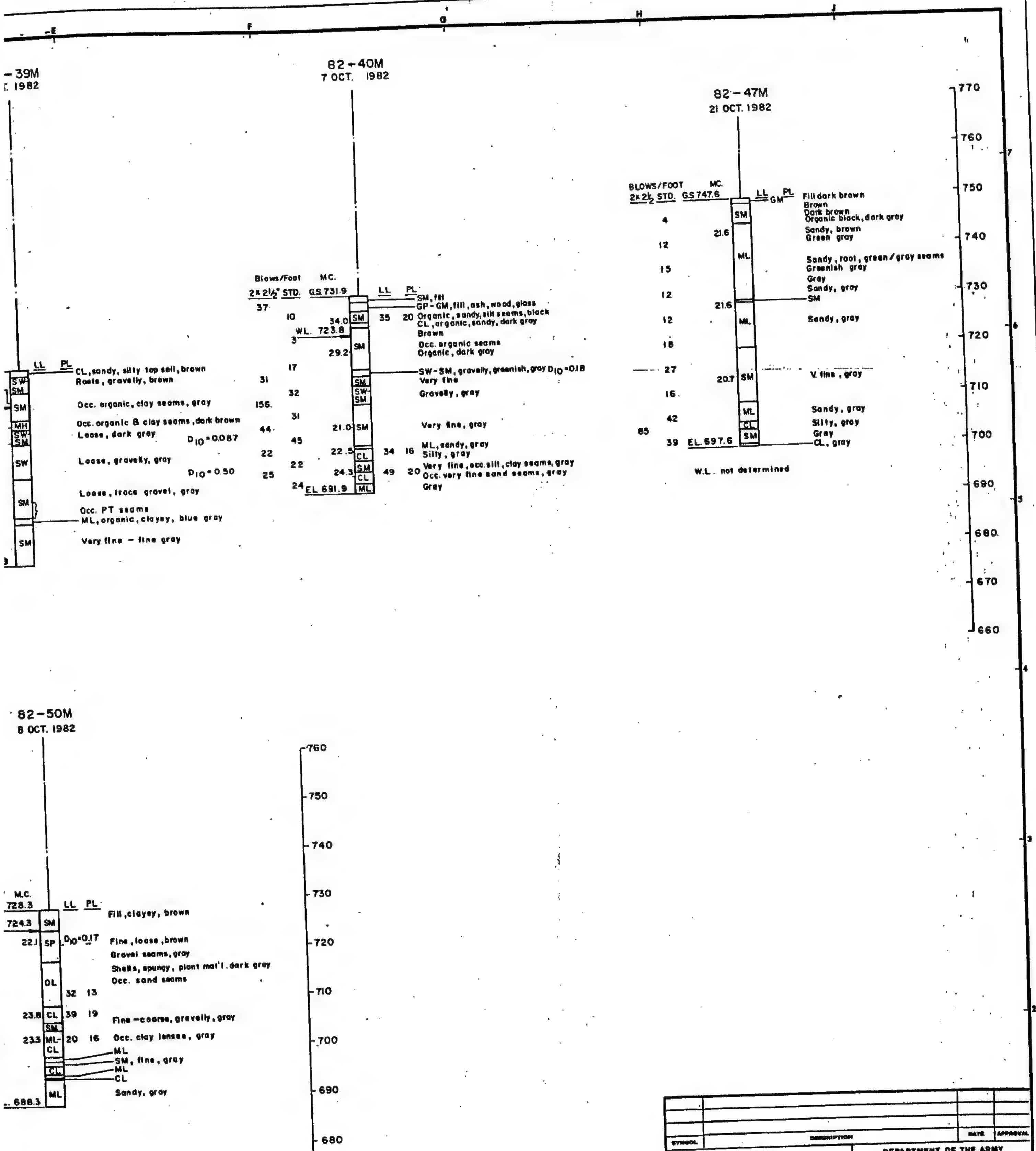
2

PLATE C-19

CONTRACT NO. DACW37-89-C-1004



82-37M
11 MAR. 1982
Blows/Foot 2x2½" STD
M.C.
G.S. 719.6
W.L. 717.3
LL PL
Muck, sandy, silty
SW, organic, gravelley
Clayey, silty, black
Sandy, gray, black*
Muck, silty, sandy, black
Organic, sandy, black
SM, muck, clayey, black
Gray
Greenish
Organic, loose, gray, black
Silty, loose, gray
PT, organic seams, brown
Gray
CL, organic, brown
SP, fine
Laminated, silt seams, gray
Fine, gray
Very fine, green gray
EL 680.6
*Classified from undisturbed sample
82-38M
14 OCT 1982
Blows/Foot 2x2½" STD.
M.C.
G.S. 769.1
LL PL
Road fill loose, brown
Loose, black
Brown
GW-GM, brown
SM, brown
Brown
W.L. 752.7
Very fine
Very fine, sandy, gray
Sandy, gray
Sandy, clayey, occ. sand & clay seams, gray
Gray
Gray
Clayey
Gray
Silty, gray
Silty, gray
Laminated, gray
Laminated, gray
Varved, gray
Gravelly, gray
EL 679.1
82-39M
16 OCT. 1982
Blows/Foot 2x2½" STD.
M.C.
G.S. 718.8
LL PL
CL, sandy, silty top soil, brown
Roots, gravelly, brown
W.L. 711.4
Occ. organic, clay seams, gr
Occ. organic & clay seams, da
Loose, dark gray
Loose, gravelly, gray
Loose, trace gravel, gray
Occ. PT seams
ML, organic, clayey, blue
Very fine - fine gray
EL 678.8
82-48M
21-22 OCT. 1982
BLOWS/FOOT STD
M.C.
W.L., G.S. 726.9
LL PL
Black
SM, organic brown
OL, black
Organic, trace gravel, gray
Organic, silty, black
Sandy, silty, greenish
Greenish
Gray
Occ. sand & silt lenses, gray
V. fine, gray
Silt & sand lenses, gray
EL. 686.9
82-49M
19 OCT. 1982
BLOWS/FOOT 2x2½ STD.
M.C.
G.S. 743.9
W.L. 740.5
LL PL
Fill, some gravel, brown
Organic, dark brown
Organic, dark brown
Clayey, light green
Sandy, gray
Occ. sand seams, laminated, gray
Clayey, laminated, gray
Occ. sandey seams, gray
Silty, gray
Silty, sand lenses, light gray
Silty, occ. sand & silt lenses, light gray
ML, clayey, gray
V. fine, gray
EL. 683.9
82-50M
8 OCT. 1982
BLOWS/FOOT STD.
M.C.
G.S. 728.3
W.L. 724.3
LL PL
Fill, clayey, brown
Fine, loose, brown
Gravel seams, gray
Shells, spungy, plant m
Occ. sand seams
Fine - coarse, gravel
Occ. clay lenses, gr
ML
SM, fine, gray
ML
CL
Sandy, gray
EL. 688.3



SYMBOL	DESCRIPTION	DATE	APPROVAL

BRW
BENNETT, RINGROSE, WOLSFELD, JARVIS, GARDNER, INC.
MINNEAPOLIS, MINNESOTA

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: PDM
DRAWN BY: GAO
CHECKED BY: LHB
SUBMITTED BY:

FLOOD CONTROL — MINNESOTA RIVER
CHASKA, MINNESOTA
CHASKA CREEK STAGE 2
BORING LOGS
82-37M THRU 82-50M

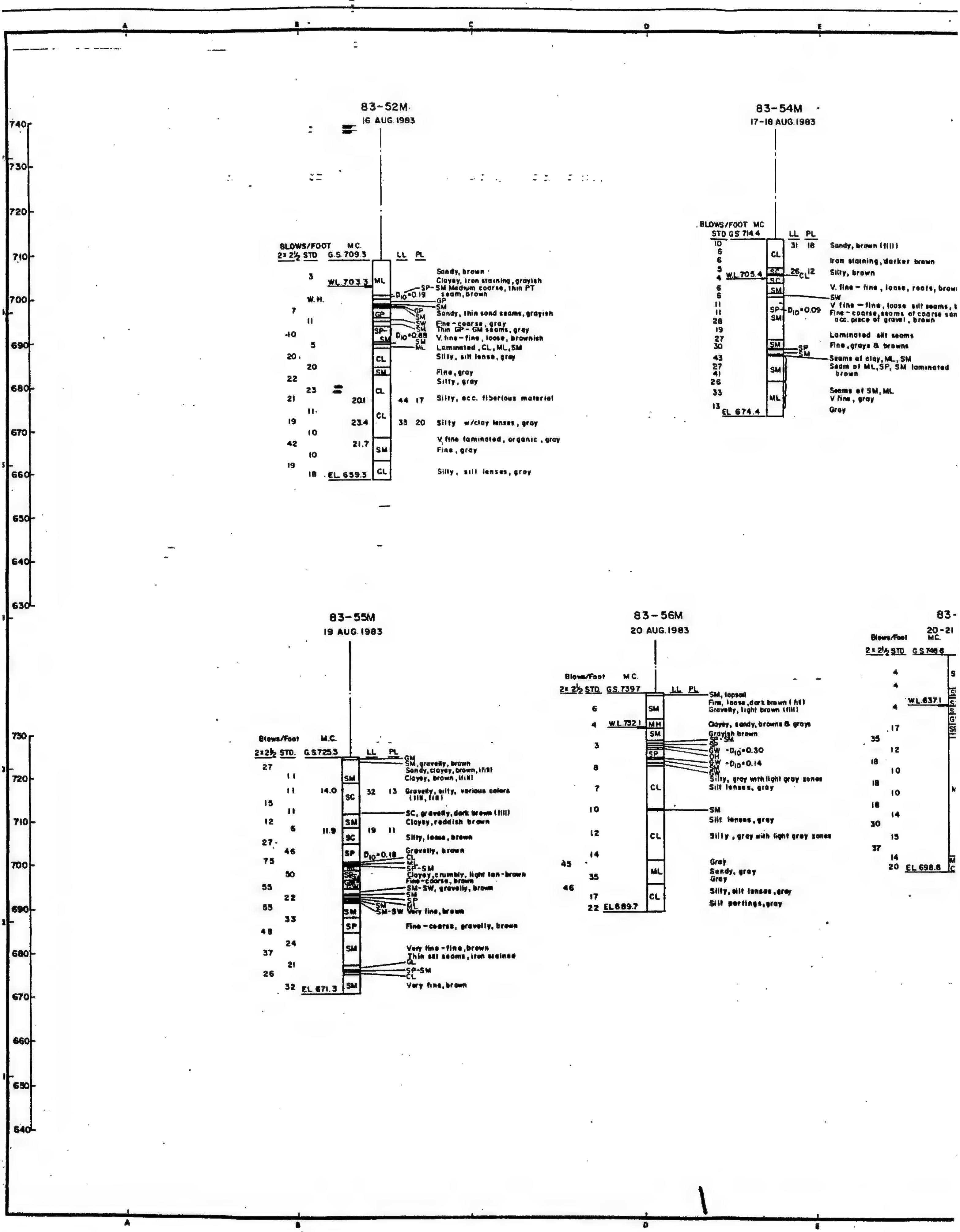
APPROVED:
DATE: MAY 1989
SCALE: AS SHOWN
SPEC. NO. DACW37-89-B-0020
DRAWING NUMBER
M34-CH-P-10/5
SHEET 5 OF 92

SAFETY PAYS

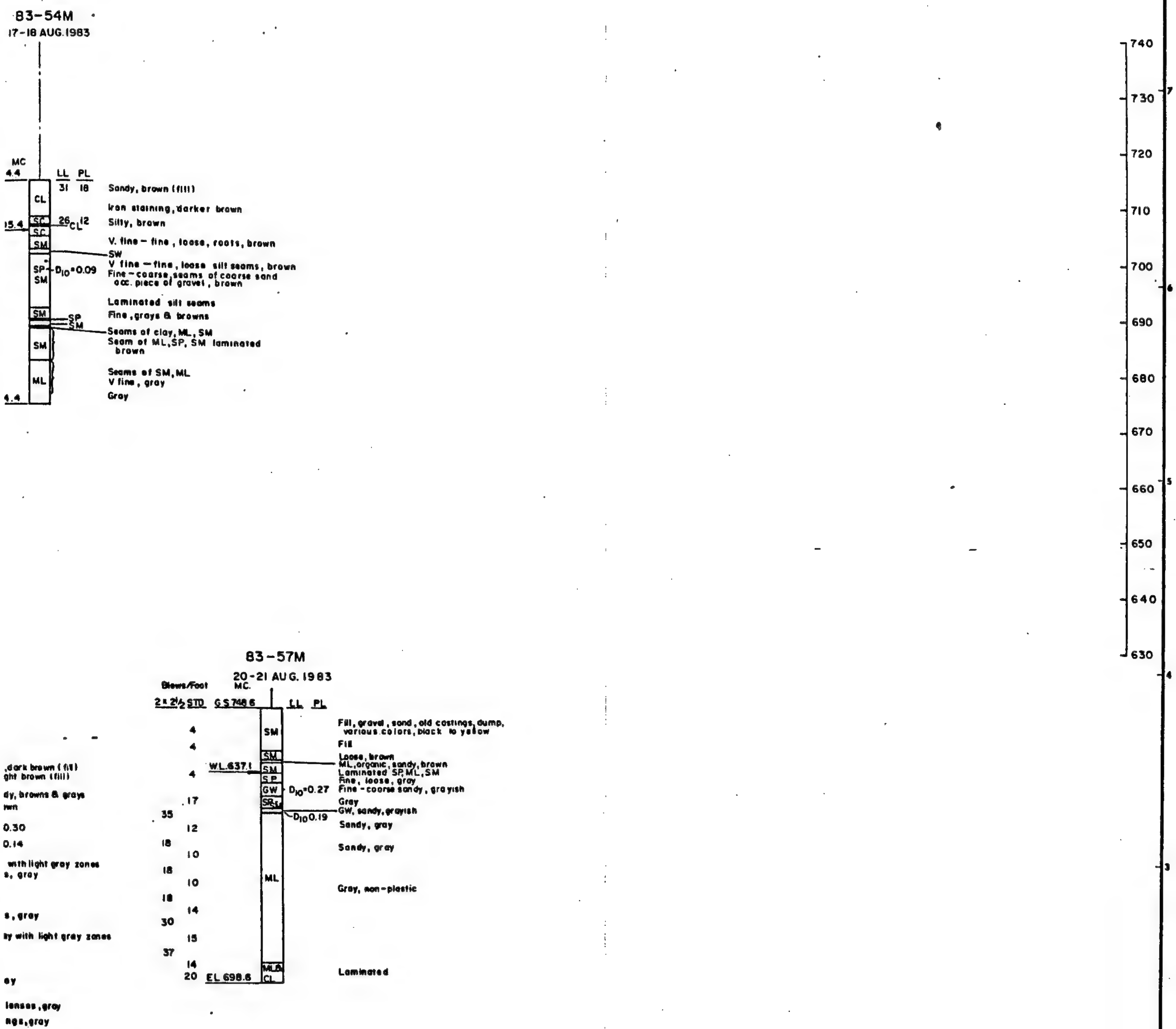
2

PLATE C-20

CONTRACT NO. DACW37-89-C-1004



83-52M
16 AUG. 1983
BLOWS/FOOT 2x2½ STD
M.C.
G.S. 709.3
LL PL
W.L. 703.3
EL. 659.3
Sandy, brown
Clayey, iron staining, grayish
SP-SM Medium coarse, thin PT seam, brown
Sandy, thin sand seams, grayish
Fine-coarse, gray
Thin GP-GM seams, gray
V. fine-fine, loose, brownish
Laminated, CL, ML, SM
Silty, silt lense, gray
Fine, gray
Silty, gray
Silty, acc. fiberious material
Silty w/clay lenses, gray
V. fine laminated, organic, gray
Fine, gray
Silty, silt lenses, gray
83-54M
17-18 AUG. 1983
BLOWS/FOOT STD
MC
GS 714.4
W.L. 705.4
EL 674.4
Sandy, brown (fill)
Iron staining, darker brown
Silty, brown
V. fine-fine, loose, roots, brown
Fine-coarse, seams of coarse sand, occ. piece of gravel, brown
Laminated silt seams
Fine, grays & browns
Seams of clay, ML, SM
Seam of ML, SP, SM laminated brown
Seams of SM, ML
V fine, gray
Gray
83-55M
19 AUG. 1983
Blows/Foot 2x2½ STD.
M.C.
G.S 725.3
LL PL
EL 671.3
SM, gravelly, brown
Sandy, clayey, brown, (fill)
Clayey, brown, (fill)
Gravelly, silty, various colors (fill, fill)
SC, gravelly, dark brown (fill)
Clayey, reddish brown
Silty, loose, brown
Gravelly, brown
Clayey, crumbly, light tan-brown
Fine-coarse, brown
SM-SW, gravelly, brown
Very fine, brown
Fine-coarse, gravelly, brown
Very fine-fine, brown
Thin silt seams, iron stained
Very fine, brown
83-56M
20 AUG. 1983
Blows/Foot 2x2½ STD.
M.C.
GS 739.7
LL PL
W.L. 732.1
EL 689.7
SM, topsoil
Fine, loose, dark brown (fill)
Gravelly, light brown (fill)
Clayey, sandy, browns & grays
Grayish brown
Silty, gray with light gray zones
Silt lenses, gray
Silt lenses, gray
Silty, gray with light gray zones
Gray
Sandy, gray
Gray
Silty, silt lenses, gray
Silt partings, gray
83-
20-21
Blows/Foot 2x2½ STD
MC.
GS 748.6
W.L. 637.1
EL 698.6



SYMBOL	DESCRIPTION	DATE	APPROVAL

BRW
BONESTROO, ROSENE, WOLSFELD, JARVIS, GARDNER, INC.
MINNEAPOLIS, MINNESOTA

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: PDM
DRAWN BY: GAO
CHECKED BY: LHB
SUBMITTED BY:

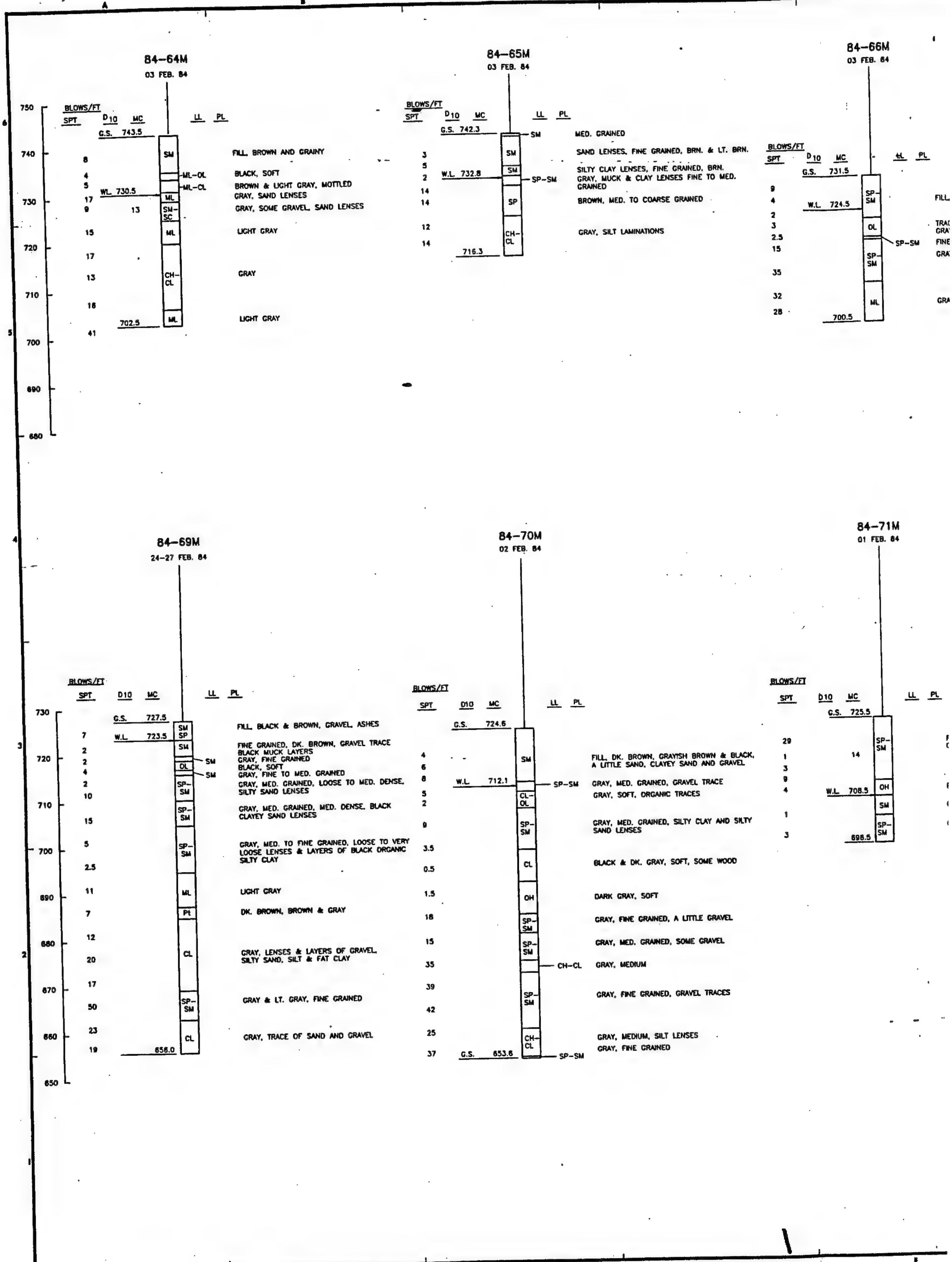
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
CHASKA CREEK STAGE 2
BORING LOGS
83-52M THRU 83-57M

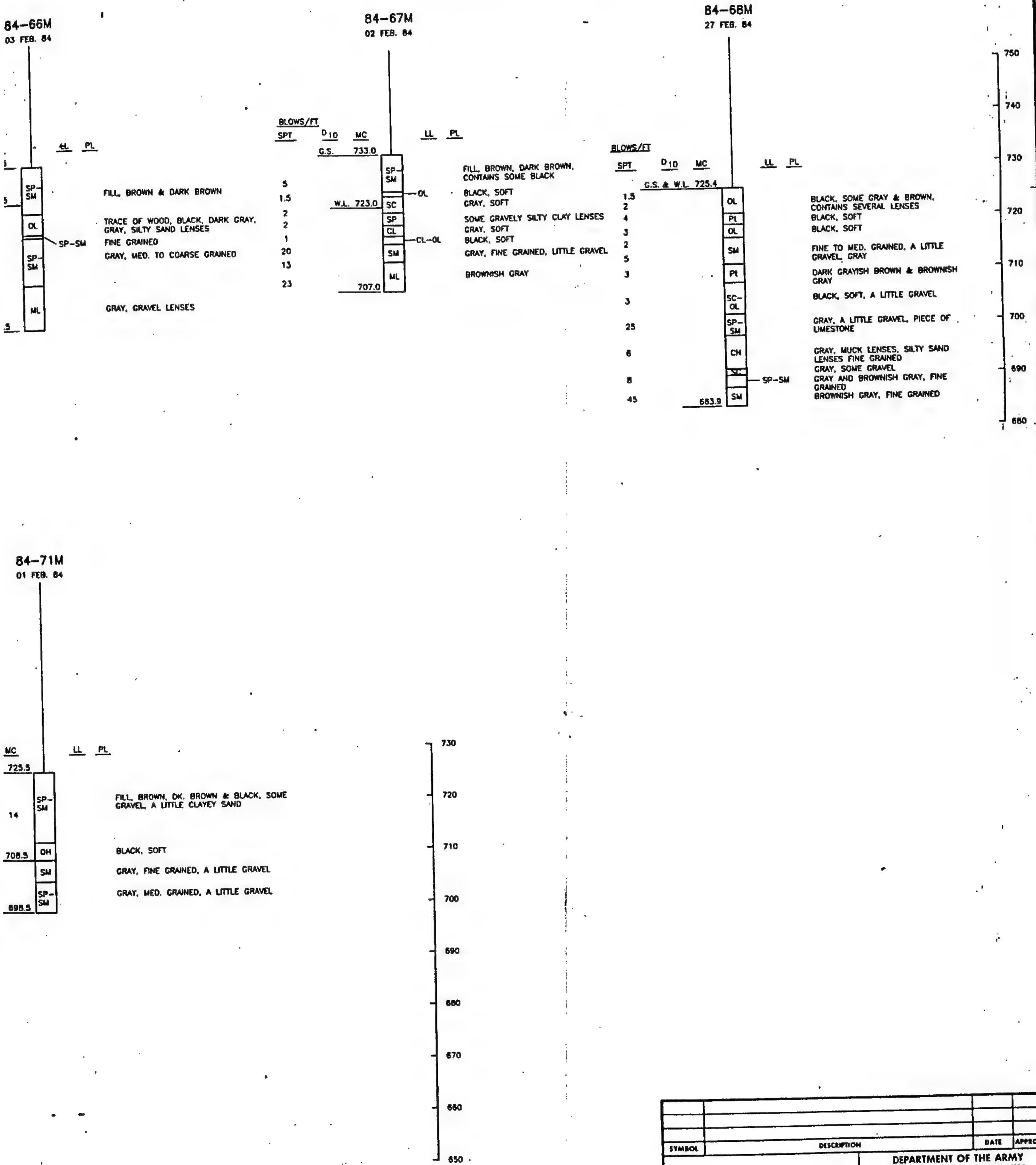
APPROVED:
DATE: MAY 1989
SCALE: AS SHOWN
SPEC. NO. DACW37-89-B-0020
DRAWING NUMBER
M34-CH-P-10/6
SHEET 6 OF 92

2

PLATE C-21

CONTRACT NO. DACW37-89-C-1004


84-64M
03 FEB. 84
BLOWS/FT
SPT
D10
MC
LL
PL
G.S. 743.5
FILL, BROWN AND GRAINY
BLACK, SOFT
BROWN & LIGHT GRAY, MOTTLED
GRAY, SAND LENSES
GRAY, SOME GRAVEL, SAND LENSES
LIGHT GRAY
GRAY
LIGHT GRAY
W.L. 730.5
702.5
SM
ML-OL
ML-CL
ML
SM-SC
ML
CH-CL
ML
84-65M
03 FEB. 84
G.S. 742.3
W.L. 732.8
716.3
SM
SP-SM
SP
CH-CL
MED. GRAINED
SAND LENSES, FINE GRAINED, BRN. & LT. BRN.
SILTY CLAY LENSES, FINE GRAINED, BRN.
GRAY, MUCK & CLAY LENSES FINE TO MED. GRAINED
BROWN, MED. TO COARSE GRAINED
GRAY, SILT LAMINATIONS
84-66M
03 FEB. 84
G.S. 731.5
W.L. 724.5
700.5
SP-SM
OL
SP-SM
ML
FILL
84-69M
24-27 FEB. 84
G.S. 727.5
W.L. 723.5
656.0
FILL, BLACK & BROWN, GRAVEL, ASHES
FINE GRAINED, DK. BROWN, GRAVEL TRACE
BLACK MUCK LAYERS
GRAY, FINE GRAINED
BLACK, SOFT
GRAY, FINE TO MED. GRAINED
GRAY, MED. GRAINED, LOOSE TO MED. DENSE, SILTY SAND LENSES
GRAY, MED. GRAINED, MED. DENSE, BLACK CLAYEY SAND LENSES
GRAY, MED. TO FINE GRAINED, LOOSE TO VERY LOOSE LENSES & LAYERS OF BLACK ORGANIC SILTY CLAY
LIGHT GRAY
DK. BROWN, BROWN & GRAY
GRAY, LENSES & LAYERS OF GRAVEL, SILTY SAND, SILT & FAT CLAY
GRAY & LT. GRAY, FINE GRAINED
GRAY, TRACE OF SAND AND GRAVEL
84-70M
02 FEB. 84
G.S. 724.6
W.L. 712.1
G.S. 653.6
FILL, DK. BROWN, GRAYISH BROWN & BLACK, A LITTLE SAND, CLAYEY SAND AND GRAVEL
GRAY, MED. GRAINED, GRAVEL TRACE
GRAY, SOFT, ORGANIC TRACES
GRAY, MED. GRAINED, SILTY CLAY AND SILTY SAND LENSES
BLACK & DK. GRAY, SOFT, SOME WOOD
DARK GRAY, SOFT
GRAY, FINE GRAINED, A LITTLE GRAVEL
GRAY, MED. GRAINED, SOME GRAVEL
GRAY, MEDIUM
GRAY, FINE GRAINED, GRAVEL TRACES
GRAY, MEDIUM, SILT LENSES
GRAY, FINE GRAINED
84-71M
01 FEB. 84
G.S. 725.5
W.L. 708.5
698.5
SP-SM
OH
SM
SP-SM



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: J.R.C.
DRAWN BY: G.R.S.
CHECKED BY: P.A.W.
SUBMITTED BY:
CHIEF DESIGN BRANCH
CHIEF BRANCH
APPROVED BY:
CHIEF ENGR. DIVISION

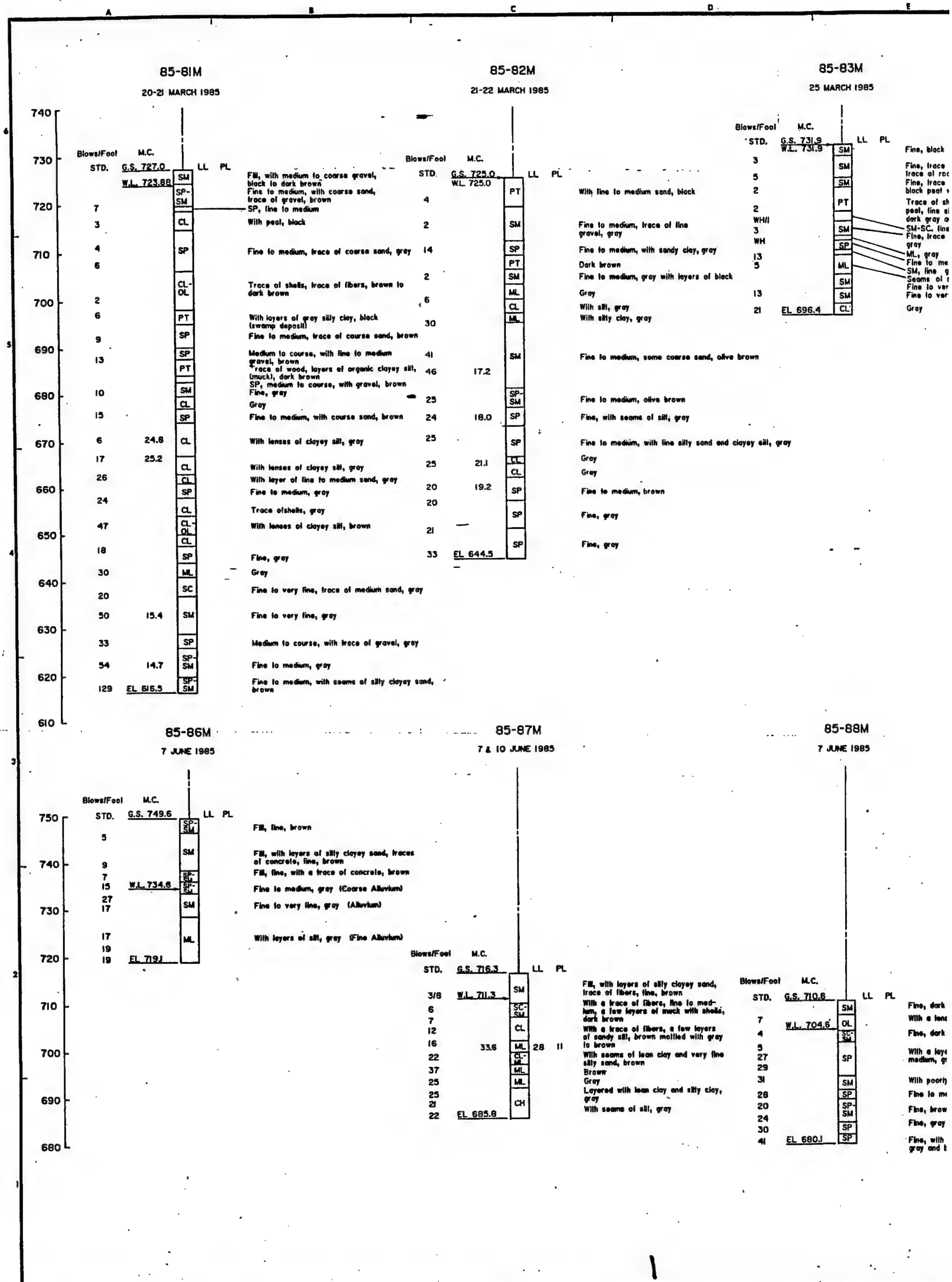
FLOOD CONTROL - MINNESOTA RIVER
CHASKA, MINNESOTA
CHASKA CREEK STAGE 2
BORING LOGS
84-64M THRU 84-71M

DATE: MAY 1989
SCALE: AS SHOWN
SPEC NO. DACW37-89-B-0020
DRAWING NUMBER: M34-CH-P-10/7
SHEET 7 OF 92

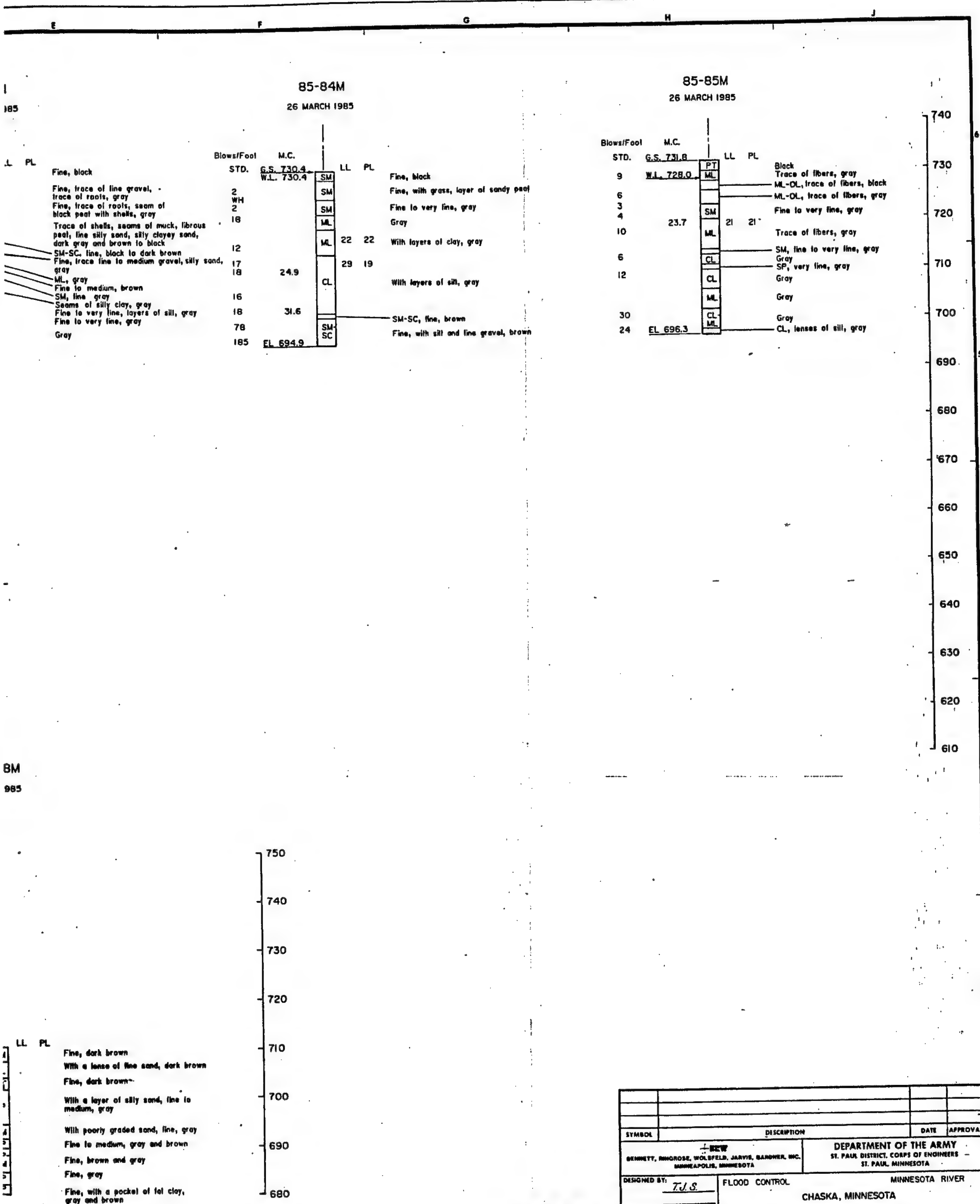
2

PLATE C-22

CONTRACT NO. DACW37-89-C-1004



85-81M
20-21 MARCH 1985
Blows/Foot STD.
M.C.
G.S. 727.0
W.L. 723.88
LL PL
Fill, with medium to coarse gravel, black to dark brown
Fine to medium, with coarse sand, trace of gravel, brown
SP, fine to medium
With peat, black
Fine to medium, trace of coarse sand, grey
Trace of shells, trace of fibers, brown to dark brown
With layers of gray silty clay, black (swamp deposit)
Fine to medium, trace of course sand, brown
Medium to course, with fine to medium gravel, brown
Trace of wood, layers of organic clayey silt, (muck), dark brown
SP, medium to course, with gravel, brown
Fine, grey
Grey
Fine to medium, with course sand, brown
With lenses of clayey silt, grey
With lenses of clayey silt, grey
With layer of fine to medium sand, grey
Fine to medium, gray
Trace of shells, gray
With lenses of clayey silt, brown
Fine, gray
Grey
Fine to very fine, trace of medium sand, gray
Fine to very fine, gray
Medium to course, with trace of gravel, gray
Fine to medium, gray
Fine to medium, with seams of silty clayey sand, brown
EL 616.5
85-82M
21-22 MARCH 1985
G.S. 725.0
W.L. 725.0
With fine to medium sand, black
Fine to medium, trace of fine gravel, gray
Fine to medium, with sandy clay, gray
Dark brown
Fine to medium, gray with layers of black
Gray
With silt, gray
With silty clay, gray
Fine to medium, some coarse sand, olive brown
Fine to medium, olive brown
Fine, with seams of silt, gray
Fine to medium, with fine silty sand and clayey silt, gray
Gray
Gray
Fine to medium, brown
Fine, gray
Fine, gray
EL 644.5
85-83M
25 MARCH 1985
G.S. 731.9
W.L. 731.9
EL 696.4
85-86M
7 JUNE 1985
G.S. 749.6
W.L. 734.6
Fill, fine, brown
Fill, with layers of silty clayey sand, traces of concrete, fine, brown
Fill, fine, with a trace of concrete, brown
Fine to medium, grey (Coarse Alluvium)
Fine to very fine, gray (Alluvium)
With layers of silt, grey (Fine Alluvium)
EL 719.1
85-87M
7 & 10 JUNE 1985
G.S. 716.3
W.L. 711.3
Fill, with layers of silty clayey sand, trace of fibers, fine, brown
With a trace of fibers, fine to medium, a few layers of muck with shells, dark brown
With a trace of fibers, a few layers of sandy silt, brown mottled with gray to brown
With seams of lean clay and very fine silty sand, brown
Brown
Gray
Layered with lean clay and silty clay, gray
With seams of silt, gray
EL 685.8
85-88M
7 JUNE 1985
G.S. 710.6
W.L. 704.6
EL 680.1



SYMBOL	DESCRIPTION	DATE	APPROVAL

BENNETT, RINGROSE, WOLSFELD, JARVIS, GARDNER, INC. MINNEAPOLIS, MINNESOTA

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: T.J.S.
DRAWN BY: N.S.
CHECKED BY: GJE
SUBMITTED BY:

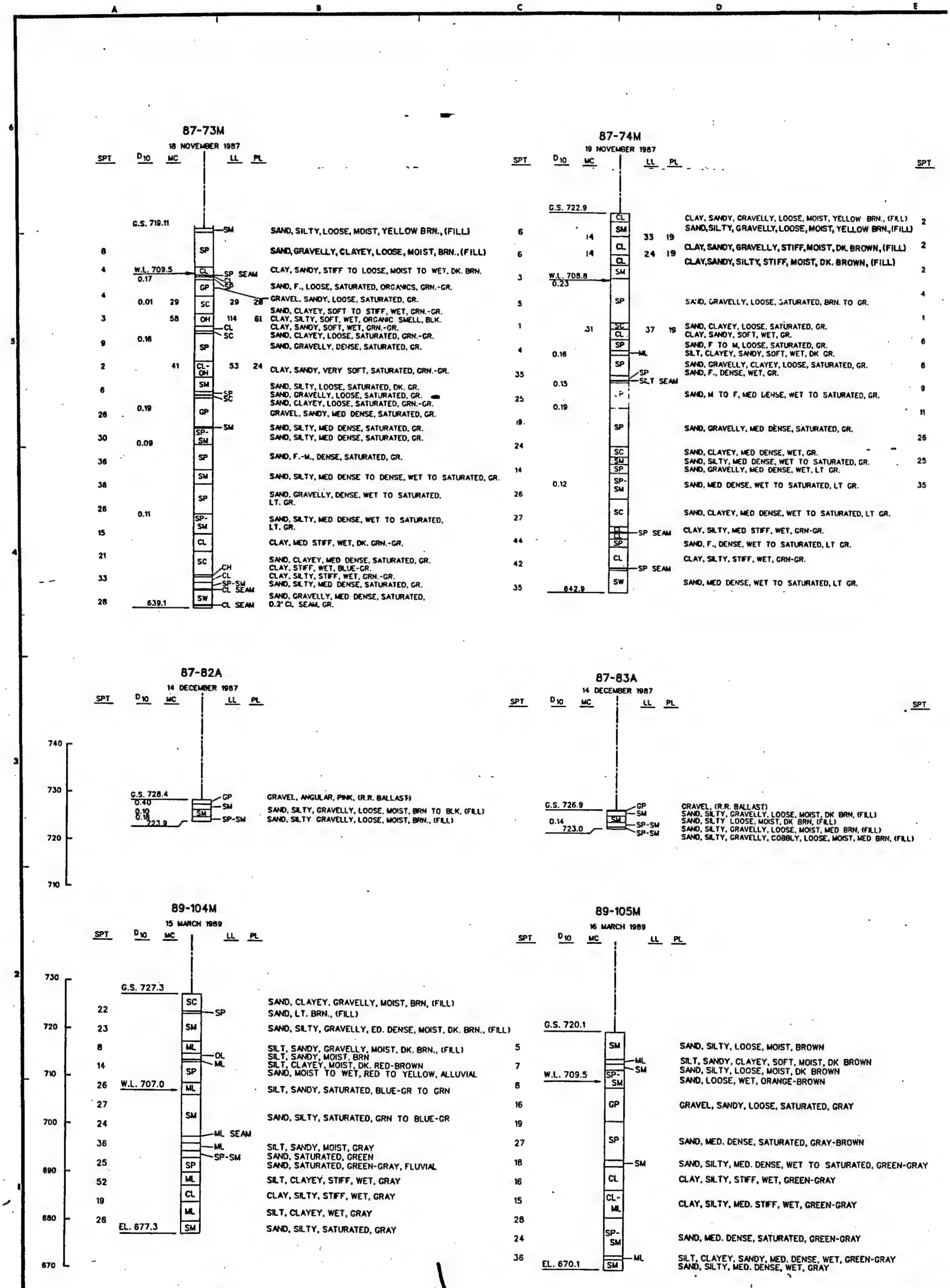
FLOOD CONTROL — MINNESOTA RIVER
CHASKA, MINNESOTA
CHASKA CREEK STAGE 2
BORING LOGS
85-81M THRU 85-88M

APPROVED BY:
DATE: MAY 1989
SCALE: AS SHOWN
SPEC. NO. DACW37-89-B-0020
DRAWING NUMBER M34-CH-P-10/8
SHEET 8 OF 92

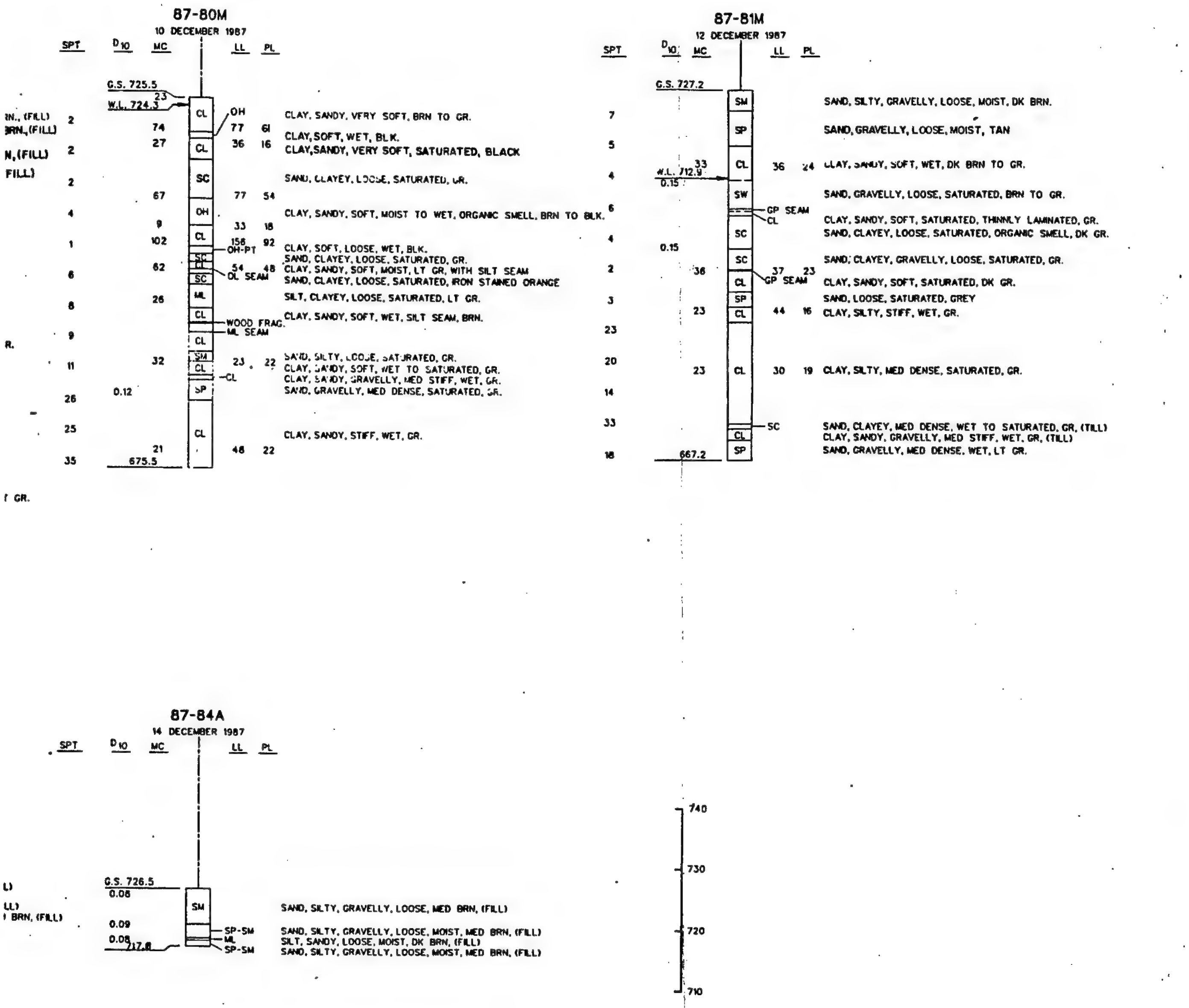
2

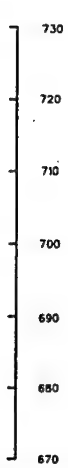
PLATE C-23

CONTRACT NO. DACW37-89-C-1004



87-73M
18 NOVEMBER 1987
SPT D10 MC LL PL
G.S. 719.11
SAND, SILTY, LOOSE, MOIST, YELLOW BRN., (FILL)
SAND, GRAVELLY, CLAYEY, LOOSE, MOIST, BRN., (FILL)
W.L. 709.5
CLAY, SANDY, STIFF TO LOOSE, MOIST TO WET, DK. BRN.
SP SEAM
SAND, F., LOOSE, SATURATED, ORGANICS, GRN.-GR.
GRAVEL, SANDY, LOOSE, SATURATED, GR.
SAND, CLAYEY, SOFT TO STIFF, WET, GRN.-GR.
CLAY, SILTY, SOFT, WET, ORGANIC SMELL, BLK.
CLAY, SANDY, SOFT, WET, GRN.-GR.
SAND, CLAYEY, LOOSE, SATURATED, GRN.-GR.
SAND, GRAVELLY, DENSE, SATURATED, GR.
CLAY, SANDY, VERY SOFT, SATURATED, GRN.-GR.
SAND, SILTY, LOOSE, SATURATED, DK. GR.
SAND, GRAVELLY, LOOSE, SATURATED, GR.
SAND, CLAYEY, LOOSE, SATURATED, GRN.-GR.
GRAVEL, SANDY, MED DENSE, SATURATED, GR.
SAND, SILTY, MED DENSE, SATURATED, GR.
SAND, SILTY, MED DENSE, SATURATED, GR.
SAND, F.-M., DENSE, SATURATED, GR.
SAND, SILTY, MED DENSE TO DENSE, WET TO SATURATED, GR.
SAND, GRAVELLY, DENSE, WET TO SATURATED, LT. GR.
SAND, SILTY, MED DENSE, WET TO SATURATED, LT. GR.
CLAY, MED STIFF, WET, DK. GRN.-GR.
SAND, CLAYEY, MED DENSE, SATURATED, GR.
CLAY, STIFF, WET, BLUE-GR.
CLAY, SILTY, STIFF, WET, GRN.-GR.
SAND, SILTY, MED DENSE, SATURATED, GR.
CL SEAM
SAND, GRAVELLY, MED DENSE, SATURATED, 0.2' CL SEAM, GR.
639.1
CL SEAM
87-74M
19 NOVEMBER 1987
SPT D10 MC LL PL
G.S. 722.9
CLAY, SANDY, GRAVELLY, LOOSE, MOIST, YELLOW BRN., (FILL)
SAND, SILTY, GRAVELLY, LOOSE, MOIST, YELLOW BRN., (FILL)
CLAY, SANDY, GRAVELLY, STIFF, MOIST, DK. BROWN, (FILL)
CLAY, SANDY, SILTY, STIFF, MOIST, DK. BROWN, (FILL)
W.L. 708.8
SAND, GRAVELLY, LOOSE, SATURATED, BRN. TO GR.
SAND, CLAYEY, LOOSE, SATURATED, GR.
CLAY, SANDY, SOFT, WET, GR.
SAND, F TO M, LOOSE, SATURATED, GR.
SILT, CLAYEY, SANDY, SOFT, WET, DK GR.
SAND, GRAVELLY, CLAYEY, LOOSE, SATURATED, GR.
SAND, F., DENSE, WET, GR.
SILT SEAM
SAND, M TO F, MED DENSE, WET TO SATURATED, GR.
SAND, GRAVELLY, MED DENSE, SATURATED, GR.
SAND, CLAYEY, MED DENSE, WET, GR.
SAND, SILTY, MED DENSE, WET TO SATURATED, GR.
SAND, GRAVELLY, MED DENSE, WET, LT GR.
SAND, MED DENSE, WET TO SATURATED, LT GR.
SAND, CLAYEY, MED DENSE, WET TO SATURATED, LT GR.
SP SEAM
CLAY, SILTY, MED STIFF, WET, GRN-GR.
SAND, F., DENSE, WET TO SATURATED, LT GR.
CLAY, SILTY, STIFF, WET, GRN-GR.
SP SEAM
SAND, MED DENSE, WET TO SATURATED, LT GR.
642.9
87-82A
14 DECEMBER 1987
SPT D10 MC LL PL
740
730
720
710
G.S. 728.4
GRAVEL, ANGULAR, PINK, (R.R. BALLAST)
SAND, SILTY, GRAVELLY, LOOSE, MOIST, BRN TO BLK, (FILL)
SAND, SILTY GRAVELLY, LOOSE, MOIST, BRN., (FILL)
723.9
87-83A
14 DECEMBER 1987
SPT D10 MC LL PL
G.S. 726.9
GRAVEL, (R.R. BALLAST)
SAND, SILTY, GRAVELLY, LOOSE, MOIST, DK BRN, (FILL)
SAND, SILTY LOOSE, MOIST, DK BRN, (FILL)
SAND, SILTY, GRAVELLY, LOOSE, MOIST, MED BRN, (FILL)
SAND, SILTY, GRAVELLY, COBBLY, LOOSE, MOIST, MED BRN, (FILL)
723.0
89-104M
15 MARCH 1989
SPT D10 MC LL PL
730
720
710
700
690
680
670
G.S. 727.3
SAND, CLAYEY, GRAVELLY, MOIST, BRN, (FILL)
SAND, LT. BRN., (FILL)
SAND, SILTY, GRAVELLY, ED. DENSE, MOIST, DK. BRN., (FILL)
SILT, SANDY, GRAVELLY, MOIST, DK. BRN., (FILL)
SILT, SANDY, MOIST, BRN
SILT, CLAYEY, MOIST, DK. RED-BROWN
SAND, MOIST TO WET, RED TO YELLOW, ALLUVIAL
W.L. 707.0
SILT, SANDY, SATURATED, BLUE-GR TO GRN
SAND, SILTY, SATURATED, GRN TO BLUE-GR
ML SEAM
SILT, SANDY, MOIST, GRAY
SAND, SATURATED, GREEN
SAND, SATURATED, GREEN-GRAY, FLUVIAL
SILT, CLAYEY, STIFF, WET, GRAY
CLAY, SILTY, STIFF, WET, GRAY
SILT, CLAYEY, WET, GRAY
EL. 677.3
SAND, SILTY, SATURATED, GRAY
89-105M
16 MARCH 1989
SPT D10 MC LL PL
G.S. 720.1
SAND, SILTY, LOOSE, MOIST, BROWN
SILT, SANDY, CLAYEY, SOFT, MOIST, DK BROWN
SAND, SILTY, LOOSE, MOIST, DK BROWN
W.L. 709.5
SAND, LOOSE, WET, ORANGE-BROWN
GRAVEL, SANDY, LOOSE, SATURATED, GRAY
SAND, MED. DENSE, SATURATED, GRAY-BROWN
SAND, SILTY, MED. DENSE, WET TO SATURATED, GREEN-GRAY
CLAY, SILTY, STIFF, WET, GREEN-GRAY
CLAY, SILTY, MED. STIFF, WET, GREEN-GRAY
SAND, MED. DENSE, SATURATED, GREEN-GRAY
SILT, CLAYEY, SANDY, MED. DENSE, WET, GREEN-GRAY
EL. 670.1
SAND, SILTY, MED. DENSE, WET, GRAY





2

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

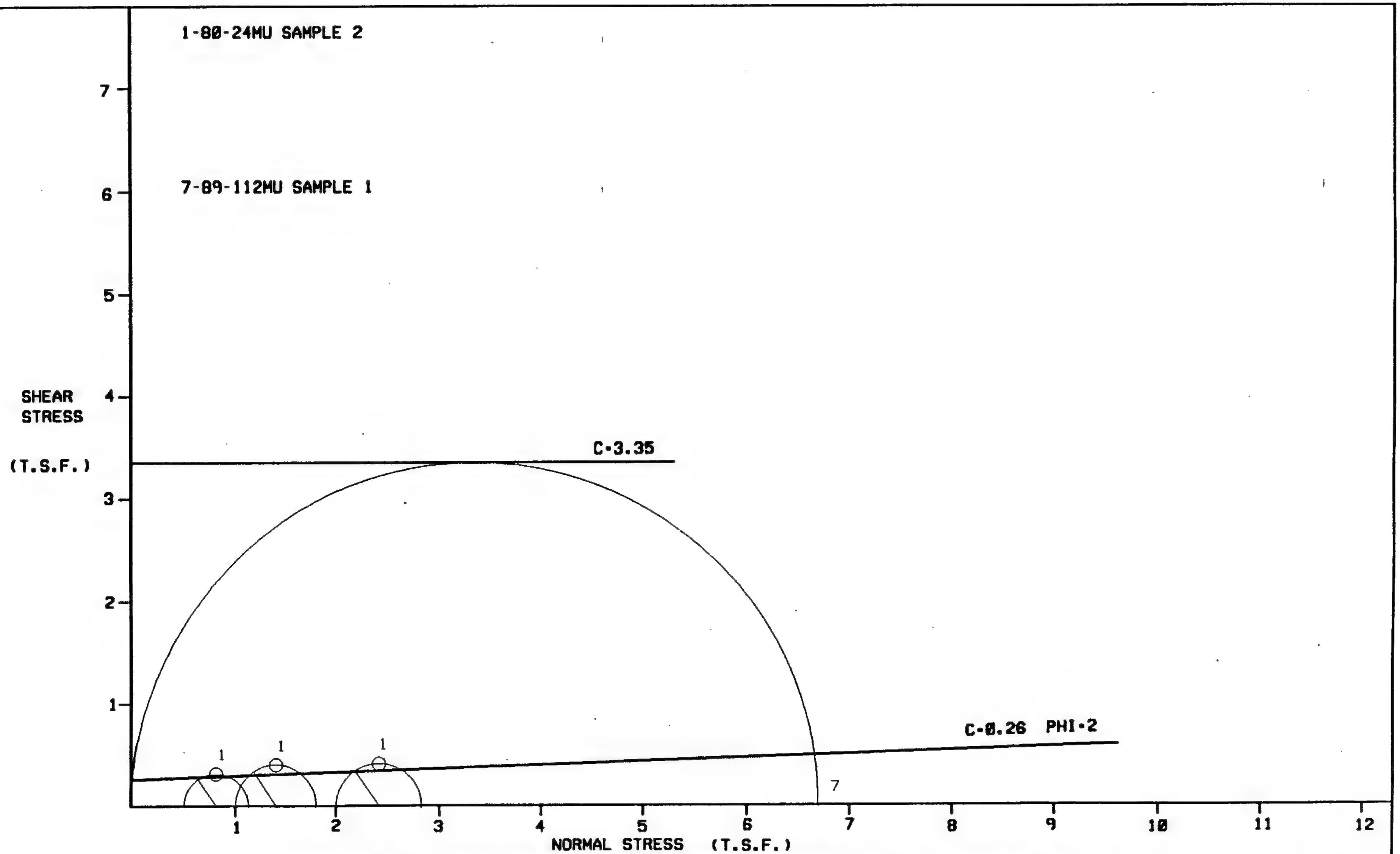
DESIGNED BY: JRC
DRAWN BY: RDC
CHECKED BY: JRC
SUBMITTED BY:

FLOOD CONTROL — MINNESOTA RIVER
CHASKA, MINNESOTA
CHASKA CREEK STAGE 2
BORING LOGS
87-73M, 87-74M, 87-80M, 87-81M, 87-82A, 87-84A, 89-104M & 89-105M

APPROVED BY:
DATE: MAY 1989
SCALE: AS SHOWN
SPEC NO. DACW37-89-B-0020
DRAWING NUMBER M34-CH-P-10/9
SHEET 9 OF 92

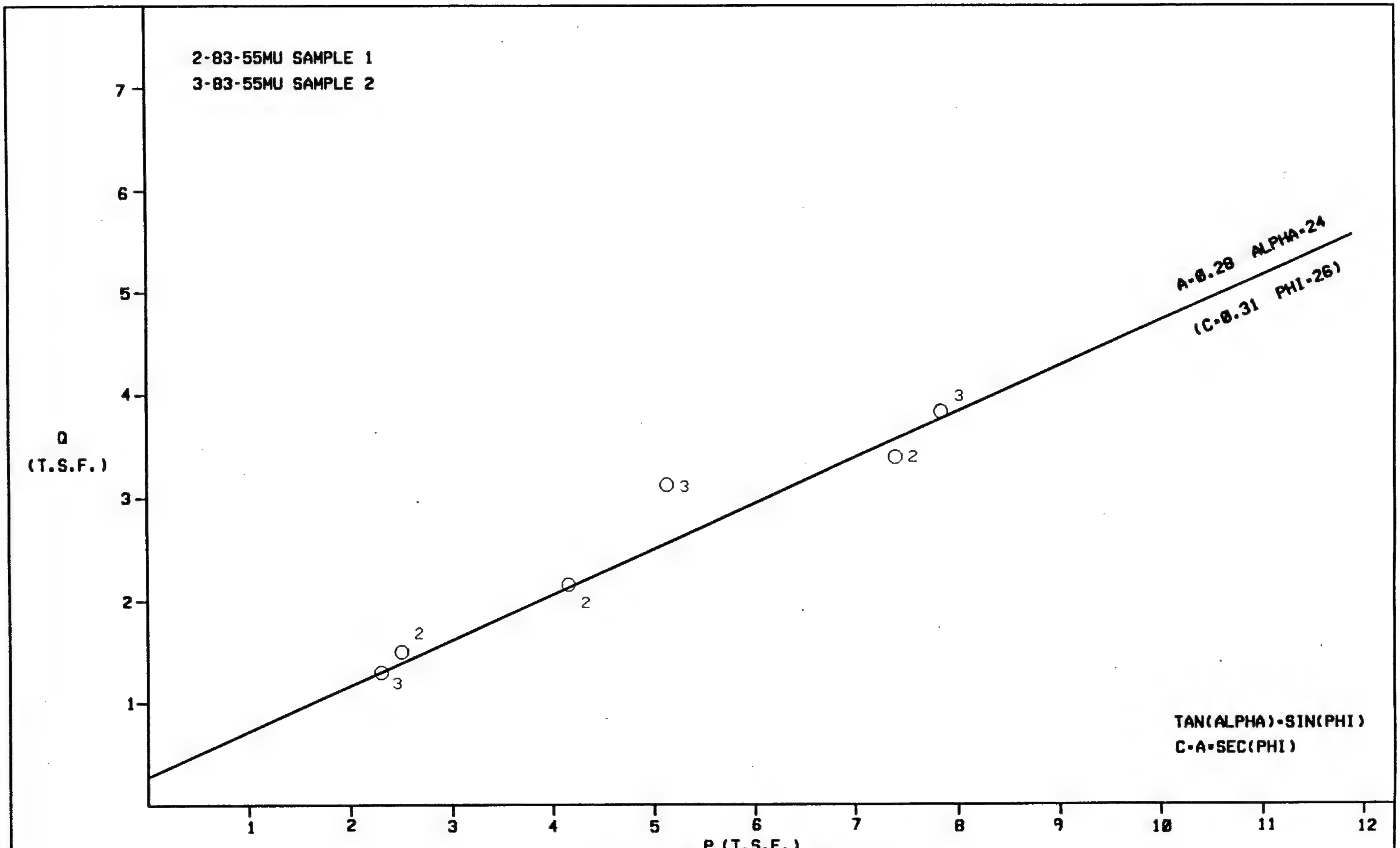
PLATE C-24

CONTRACT NO. DACW37-89-C-1004



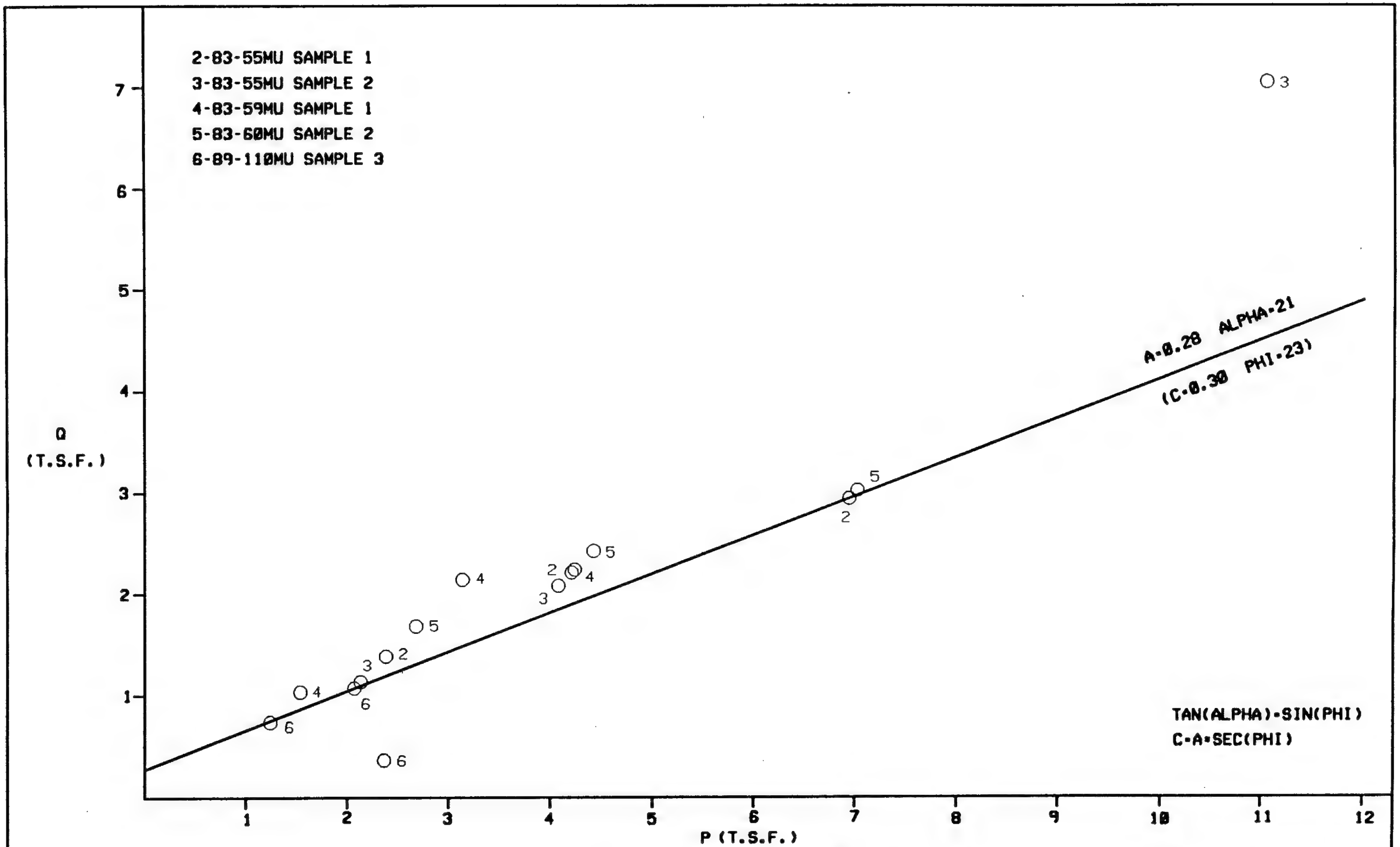
Q-TEST DATA FROM REMOLDED SAMPLE AND UNCONFINED COMPRESSION TEST FOR EXISTING LEVEE

PLATE C-25



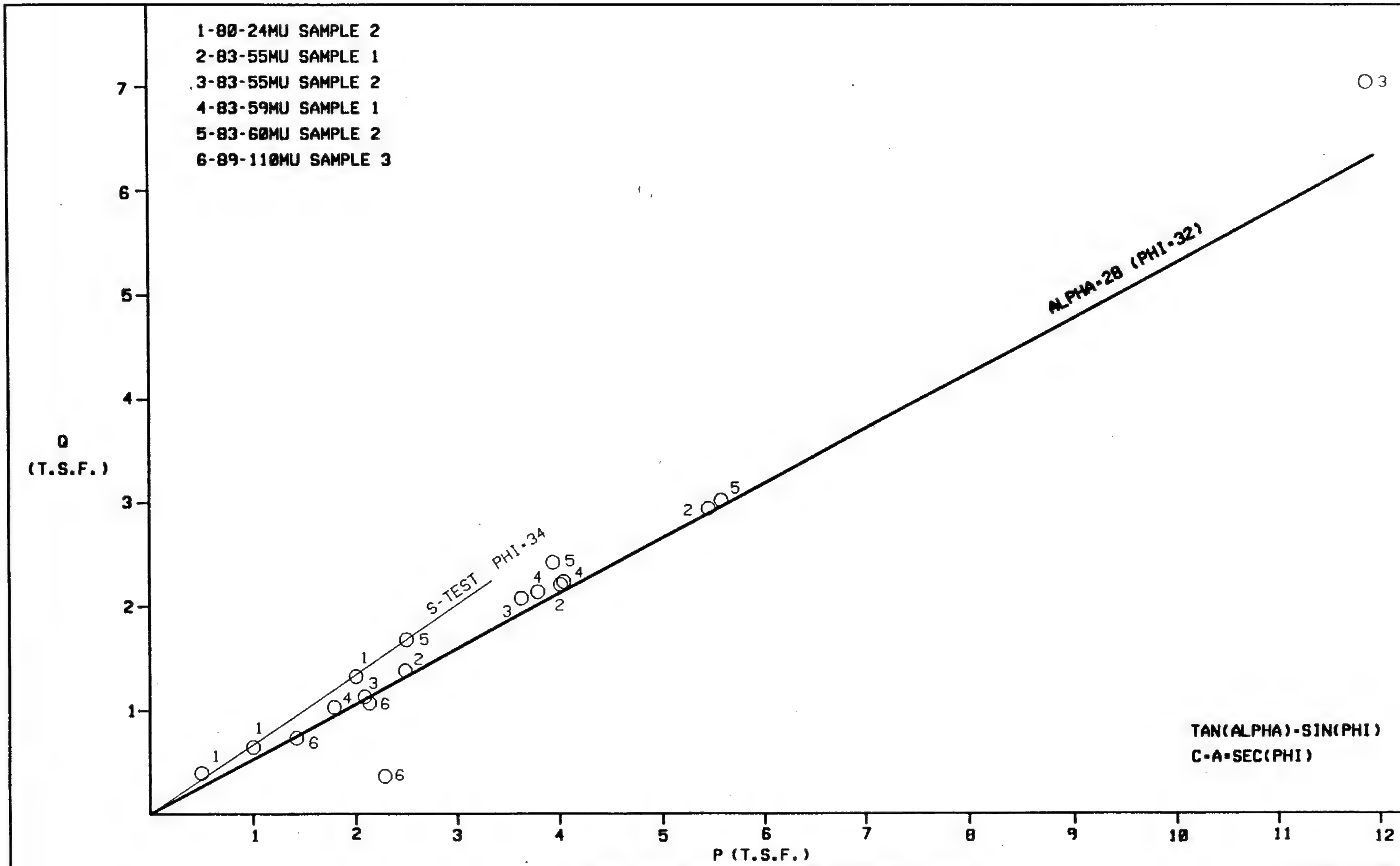
Q-TEST DATA ON EXISTING LEVEES

PLATE C-26



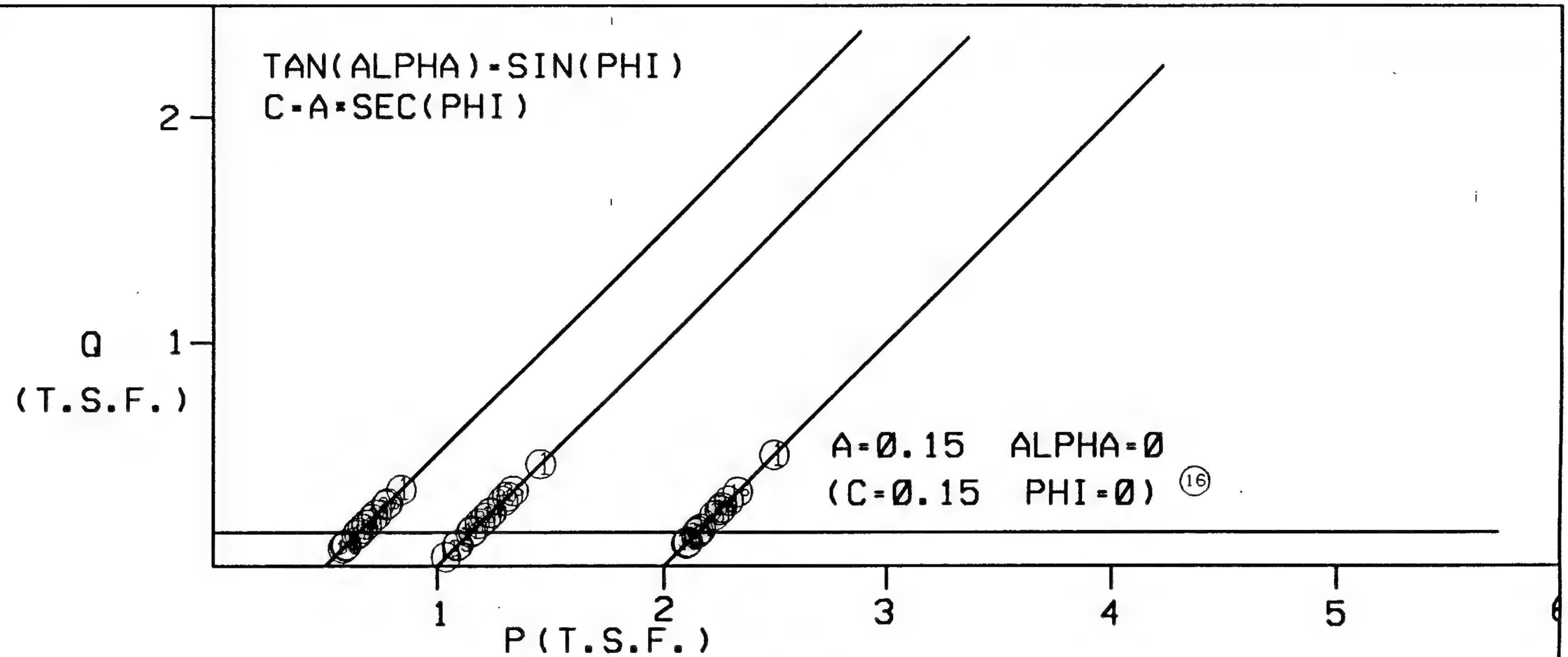
R-TEST DATA ON EXISTING LEVEES

PLATE C-27



R-BAR OR S-TEST DATA ON EXISTING LEVEES

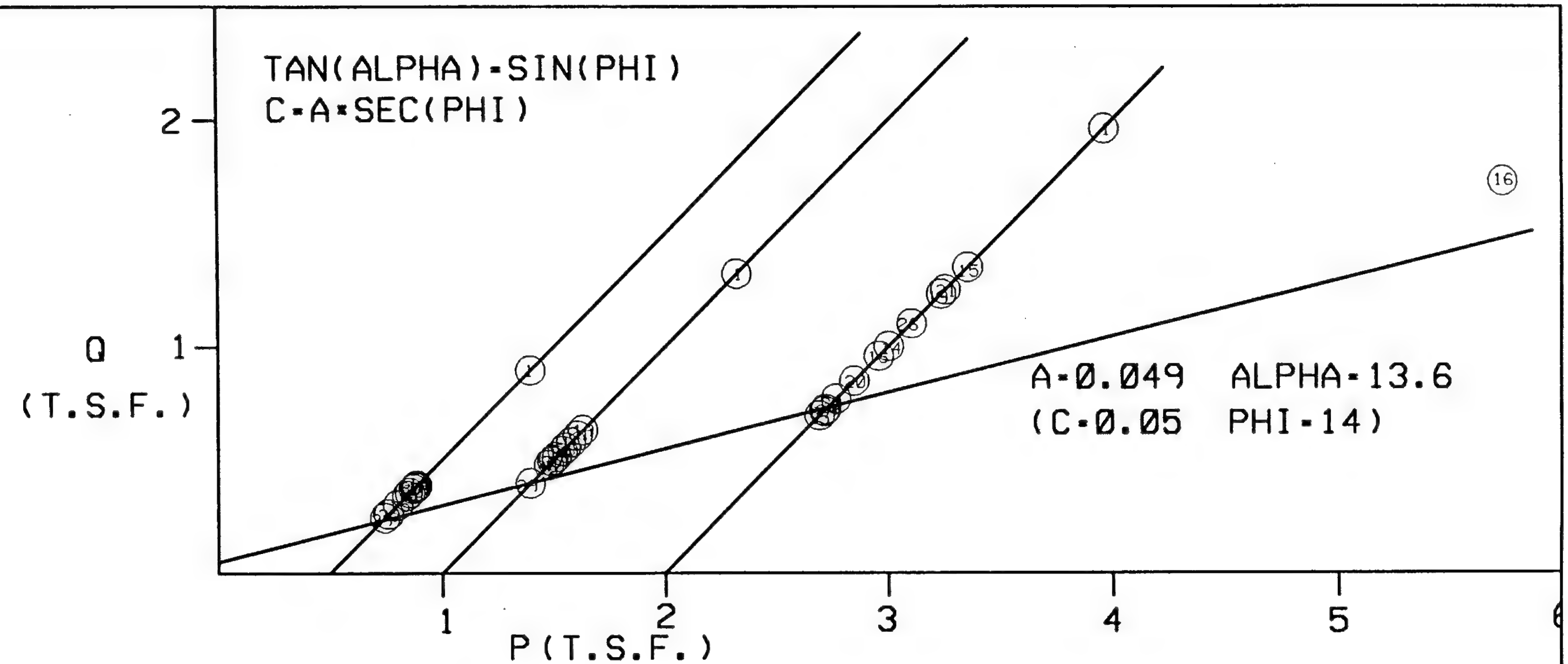
PLATE C-28



CH,SPT<=4,Q-TEST
EAST OF COURTHOUSE LAKE

SAMPLES INCLUDE:82-41MU SAMPLE 3, 82-51MU SAMPLE 1,83-62MU SAMPLE 1,
88-1Ø2MU SAMPLE 1, 88-1Ø3MU SAMPLES 1 & 3, 88-119MU SAMPLES 1,3, & 4,
89-126MU SAMPLES 1 & 2, AND 89-13ØMU SAMPLE 1
NO R-BAR TEST FOR 83-62MU SAMPLE 1

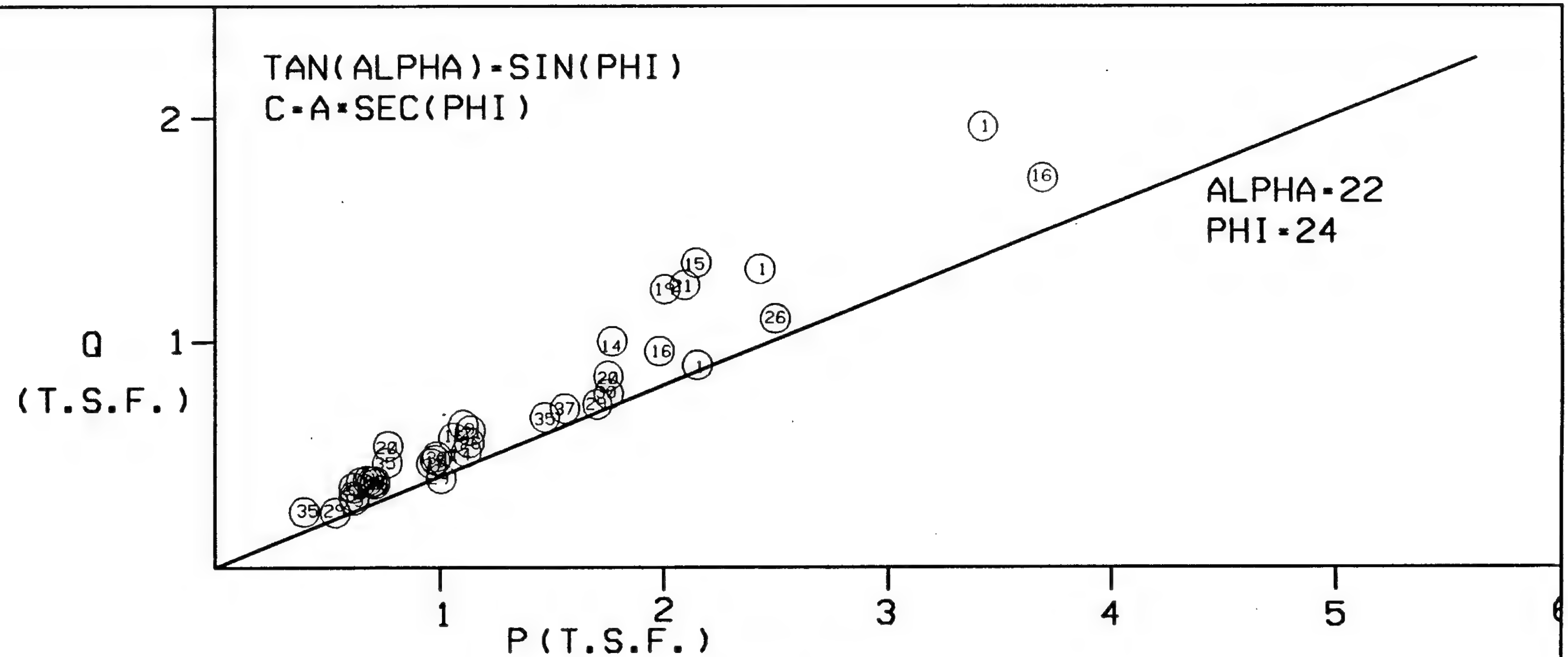
PLATE C-29



CH,SPT<=4,R-TEST
EAST OF COURTHOUSE LAKE

SAMPLES INCLUDE:82-41MU SAMPLE 3, 82-51MU SAMPLE 1,83-62MU SAMPLE 1,
88-102MU SAMPLE 1, 88-103MU SAMPLES 1 & 3, 88-119MU SAMPLES 1,3, & 4,
89-126MU SAMPLES 1 & 2, AND 89-130MU SAMPLE 1
NO R-BAR TEST FOR 83-62MU SAMPLE 1

PLATE C-30



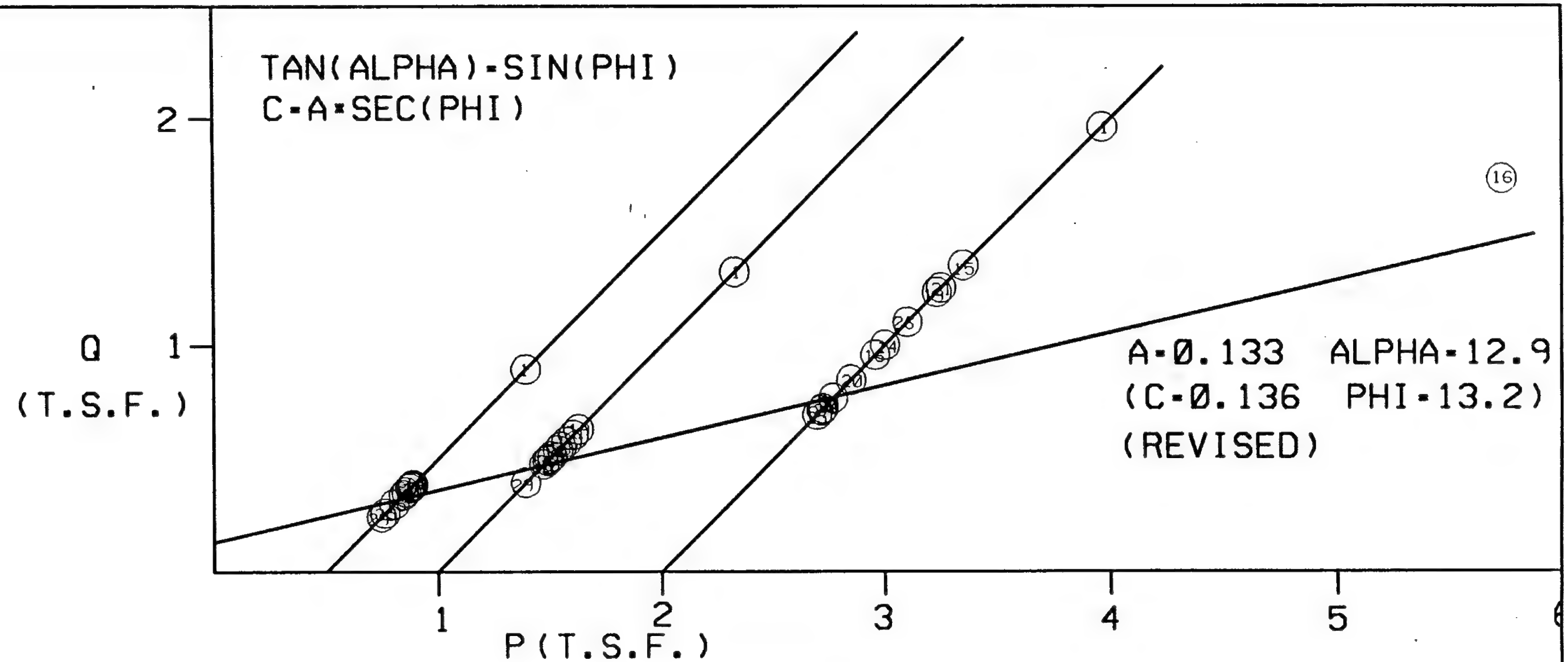
CH,SPT<=4,RBAR-TEST

EAST OF COURTHOUSE LAKE

SAMPLES INCLUDE:82-41MU SAMPLE 3, 82-51MU SAMPLE 1,83-62MU SAMPLE 1, 88-102MU SAMPLE 1, 88-103MU SAMPLES 1 & 3, 88-119MU SAMPLES 1,3, & 4, 89-126MU SAMPLES 1 & 2, AND 89-130MU SAMPLE 1

NO R-BAR TEST FOR 83-62MU SAMPLE 1

PLATE C-31

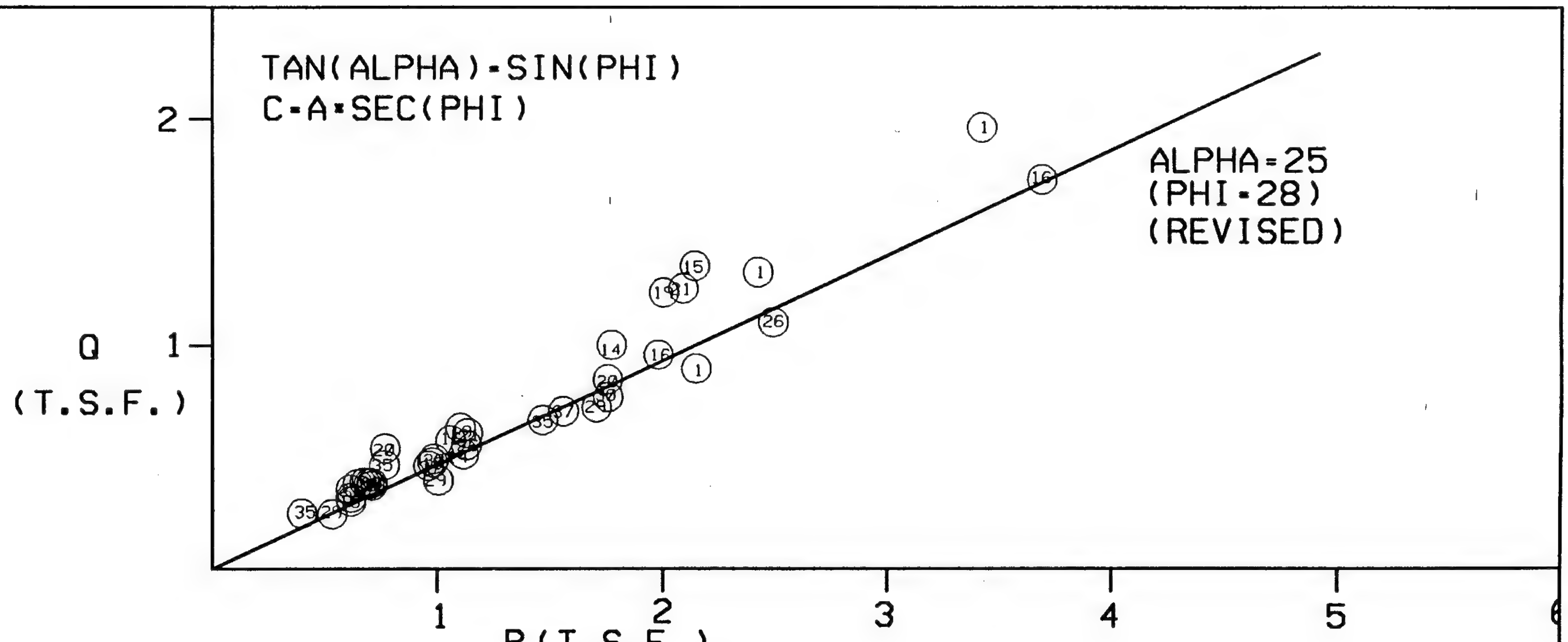


CH,SPT<=4,R-TEST
EAST OF COURTHOUSE LAKE

SAMPLES INCLUDE:82-41MU SAMPLE 3, 82-51MU SAMPLE 1,83-62MU SAMPLE 1, 88-102MU SAMPLE 1, 88-103MU SAMPLES 1 & 3, 88-119MU SAMPLES 1,3, & 4, 89-126MU SAMPLES 1 & 2, AND 89-130MU SAMPLE 1

NO R-BAR TEST FOR 83-62MU SAMPLE 1

PLATE C-32

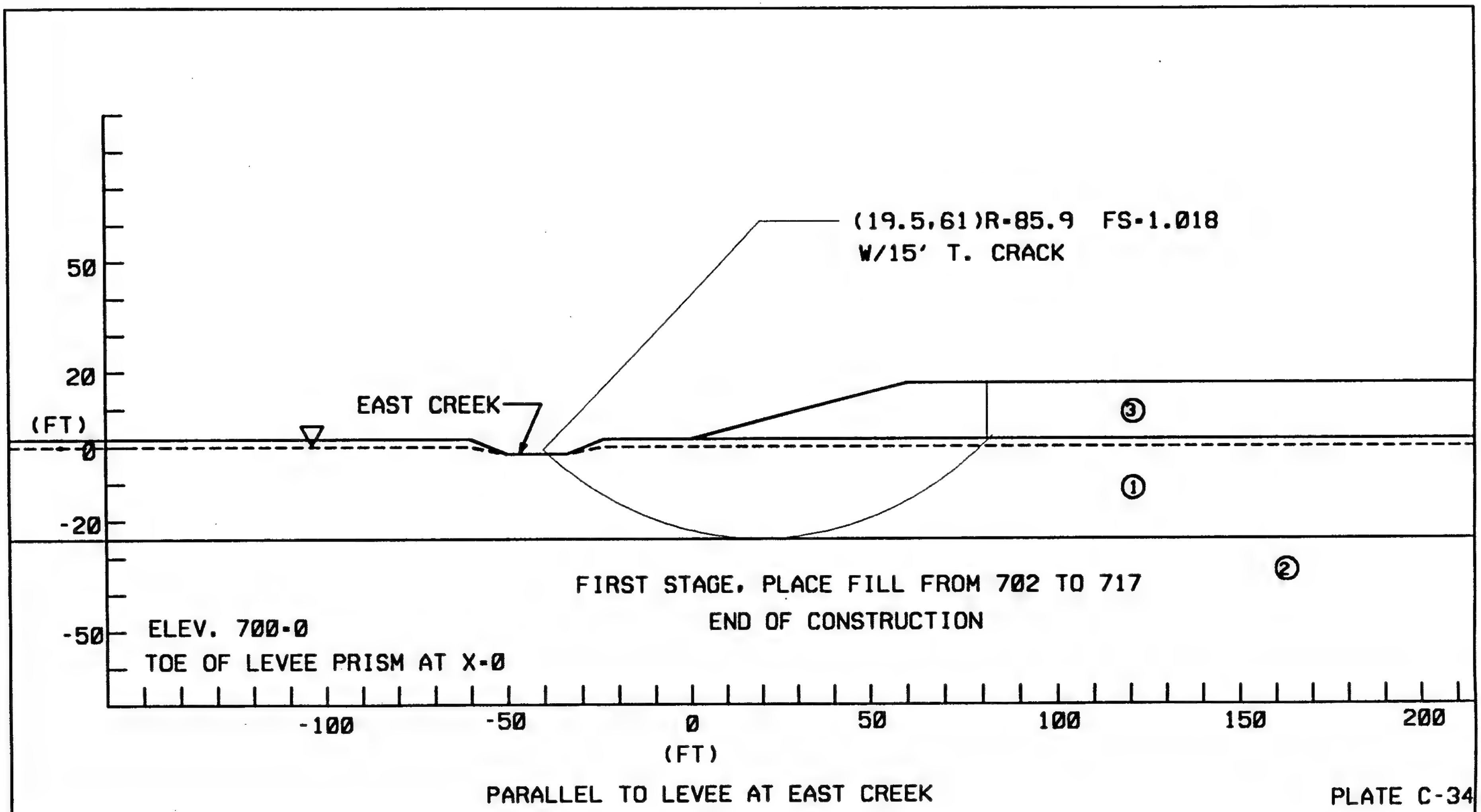


CH,SPT<=4,RBAR-TEST
EAST OF COURTHOUSE LAKE

SAMPLES INCLUDE:82-41MU SAMPLE 3, 82-51MU SAMPLE 1,83-62MU SAMPLE 1, 88-102MU SAMPLE 1, 88-103MU SAMPLES 1 & 3, 88-119MU SAMPLES 1,3, & 4, 89-126MU SAMPLES 1 & 2, AND 89-130MU SAMPLE 1

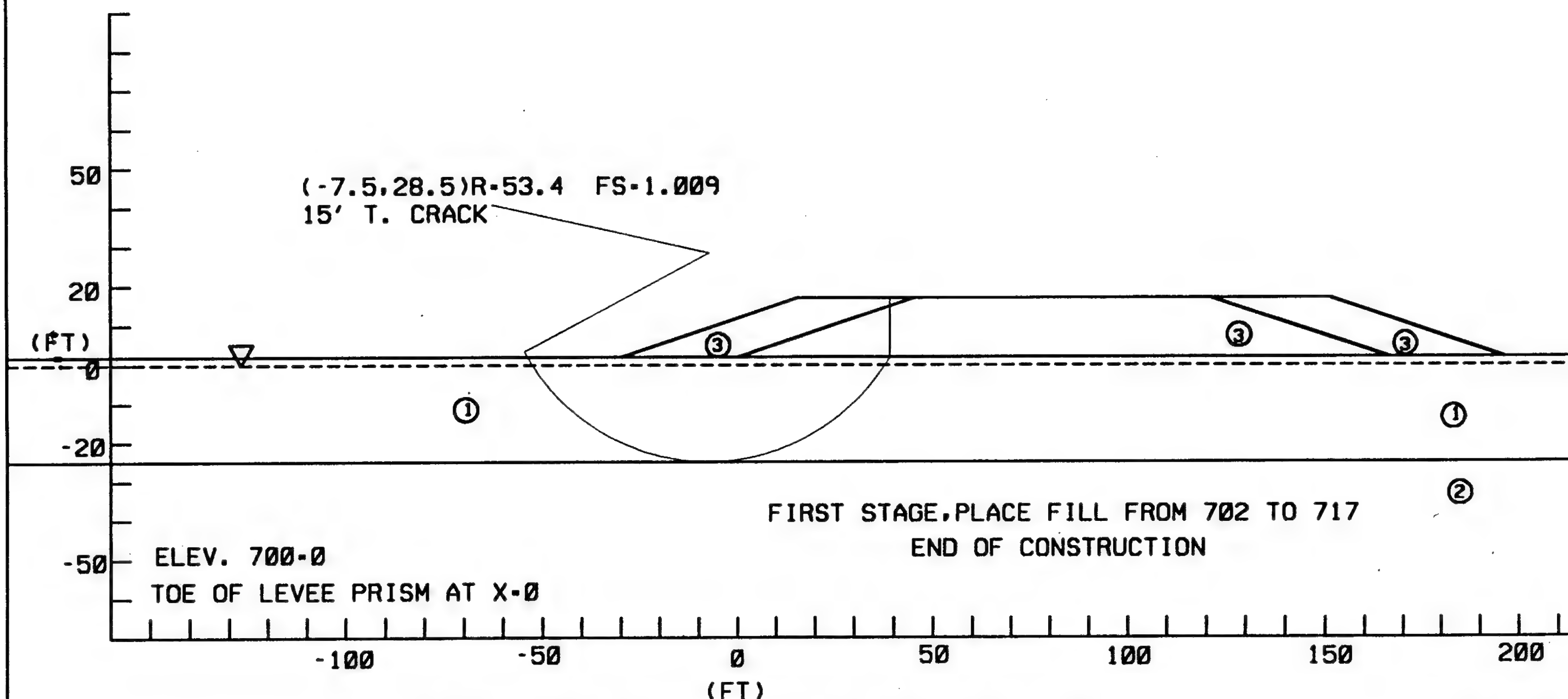
NO R-BAR TEST FOR 83-62MU SAMPLE 1

PLATE C-33



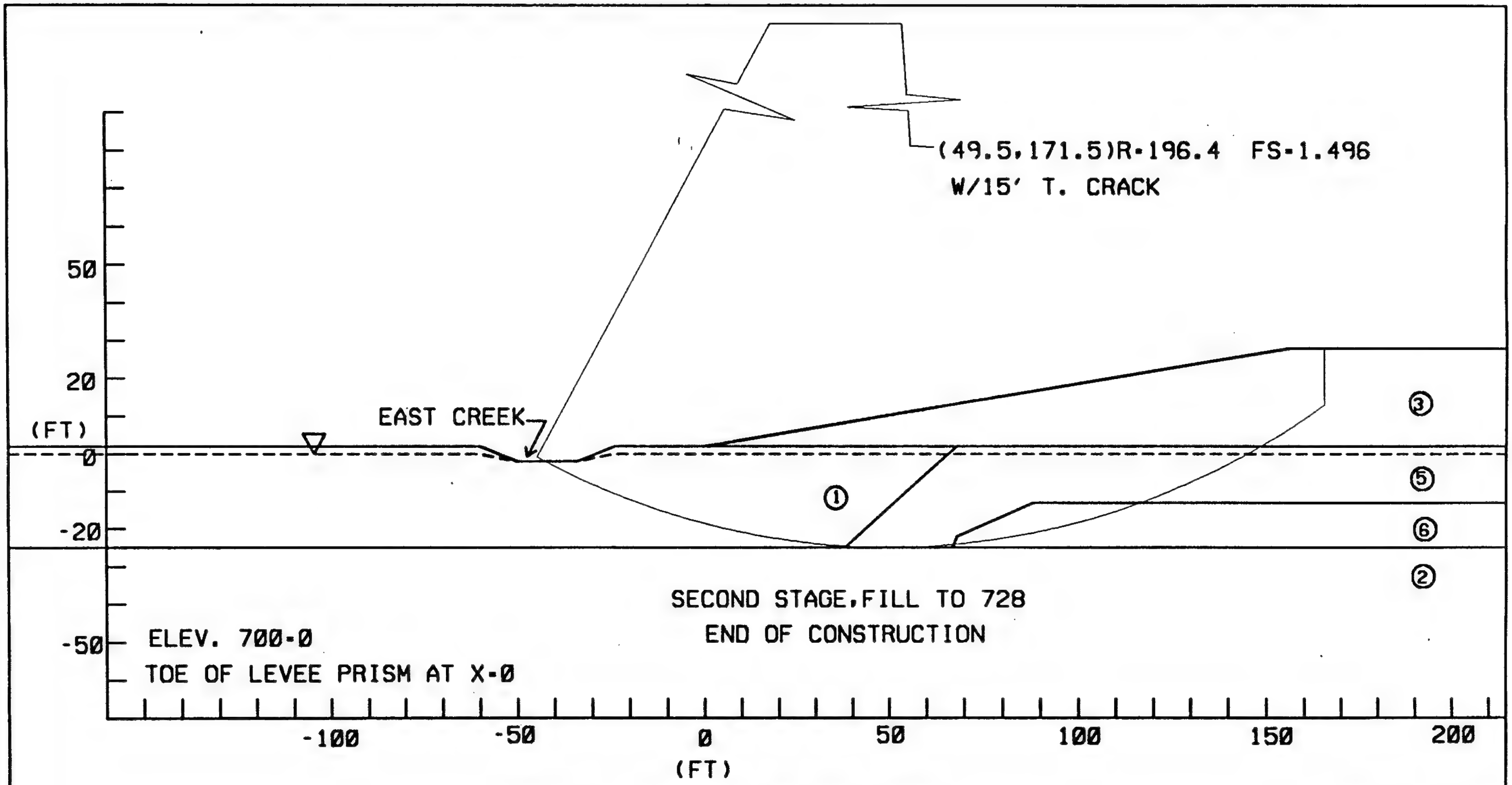
(19.5,61)R=85.9 FS=1.018
W/15' T. CRACK
EAST CREEK
50
20
(FT)
0
-20
-50
ELEV. 700.0
TOE OF LEVEE PRISM AT X=0
FIRST STAGE, PLACE FILL FROM 702 TO 717
END OF CONSTRUCTION
③
①
②
-100
-50
0
50
100
150
200
(FT)
PARALLEL TO LEVEE AT EAST CREEK

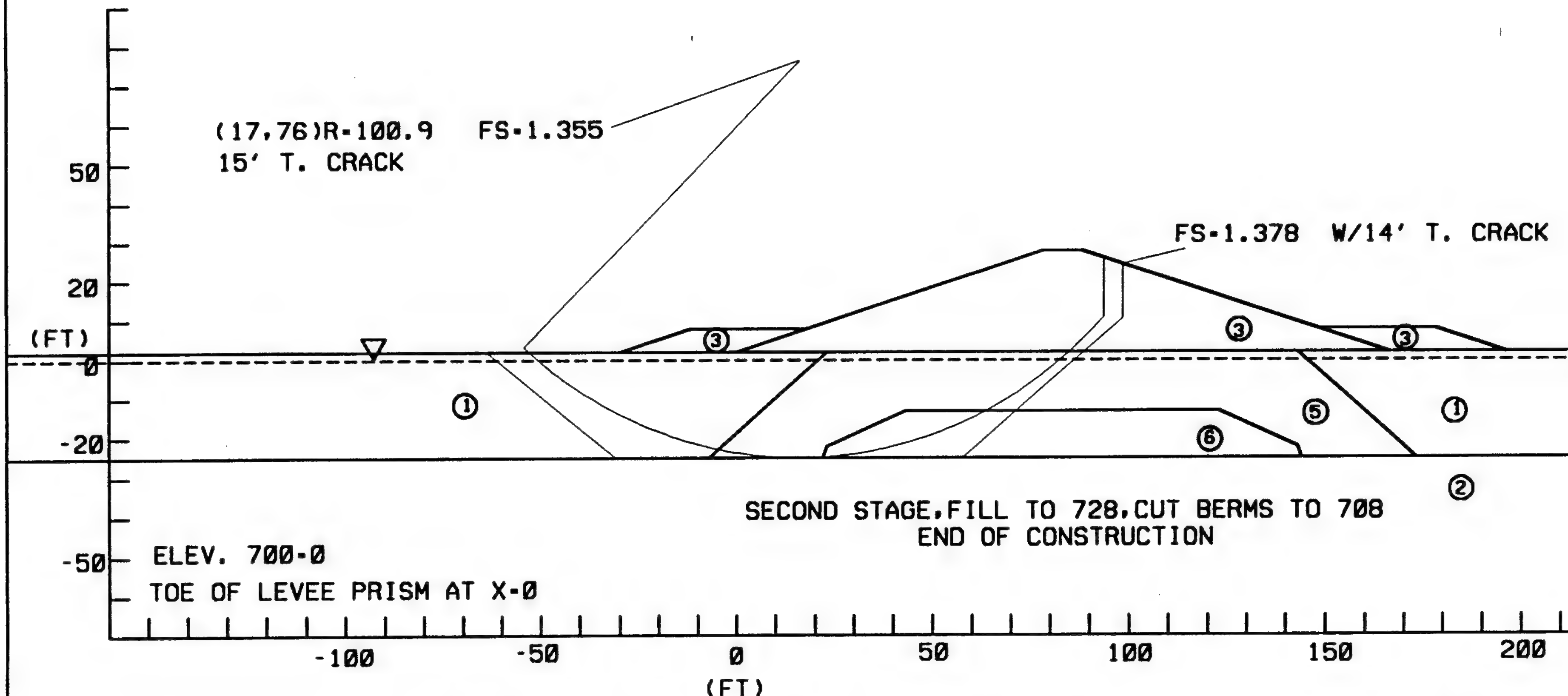
PLATE C-34



TYPICAL LEVEE SECTION EAST OF COURTHOUSE LAKE

PLATE C-35


(49.5,171.5)R-196.4 FS-1.496
W/15' T. CRACK
50
20
(FT)
0
-20
-50
EAST CREEK
① ③ ⑤ ⑥ ②
SECOND STAGE,FILL TO 728
END OF CONSTRUCTION
ELEV. 700-0
TOE OF LEVEE PRISM AT X-0
-100
-50
0
50
100
150
200
(FT)
PARALLEL TO LEVEE AT EAST CREEK



TYPICAL LEVEE SECTION EAST OF COURTHOUSE LAKE

PLATE C-37

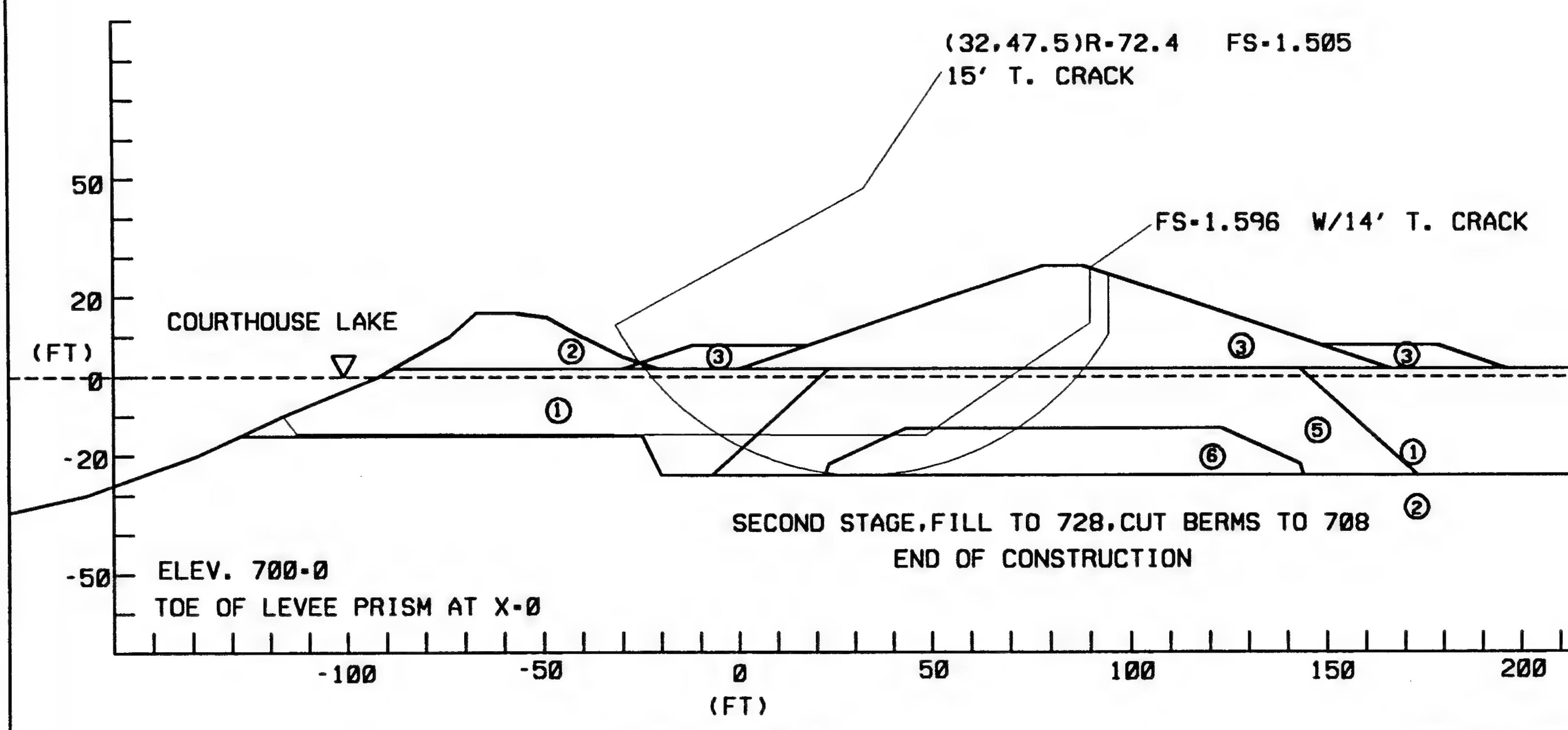

(32,47.5)R=72.4 FS=1.505
15' T. CRACK
FS=1.596 W/14' T. CRACK
COURTHOUSE LAKE
(FT)
50
20
0
-20
-50
1
2
3
5
6
SECOND STAGE,FILL TO 728,CUT BERMS TO 708
END OF CONSTRUCTION
ELEV. 700.0
TOE OF LEVEE PRISM AT X=0
-100
-50
0
50
100
150
200
(FT)
STATION 15+50

PLATE C-38

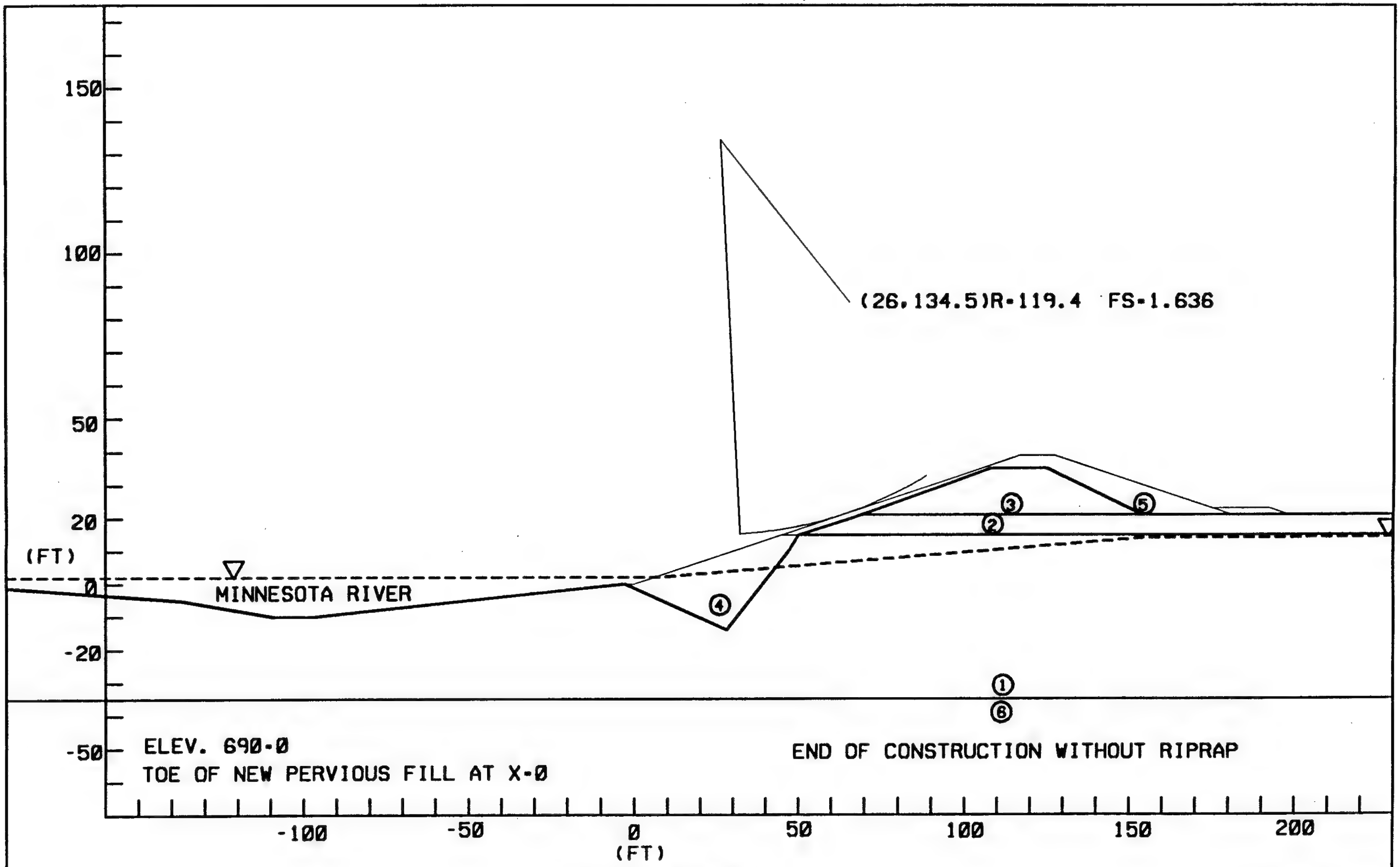
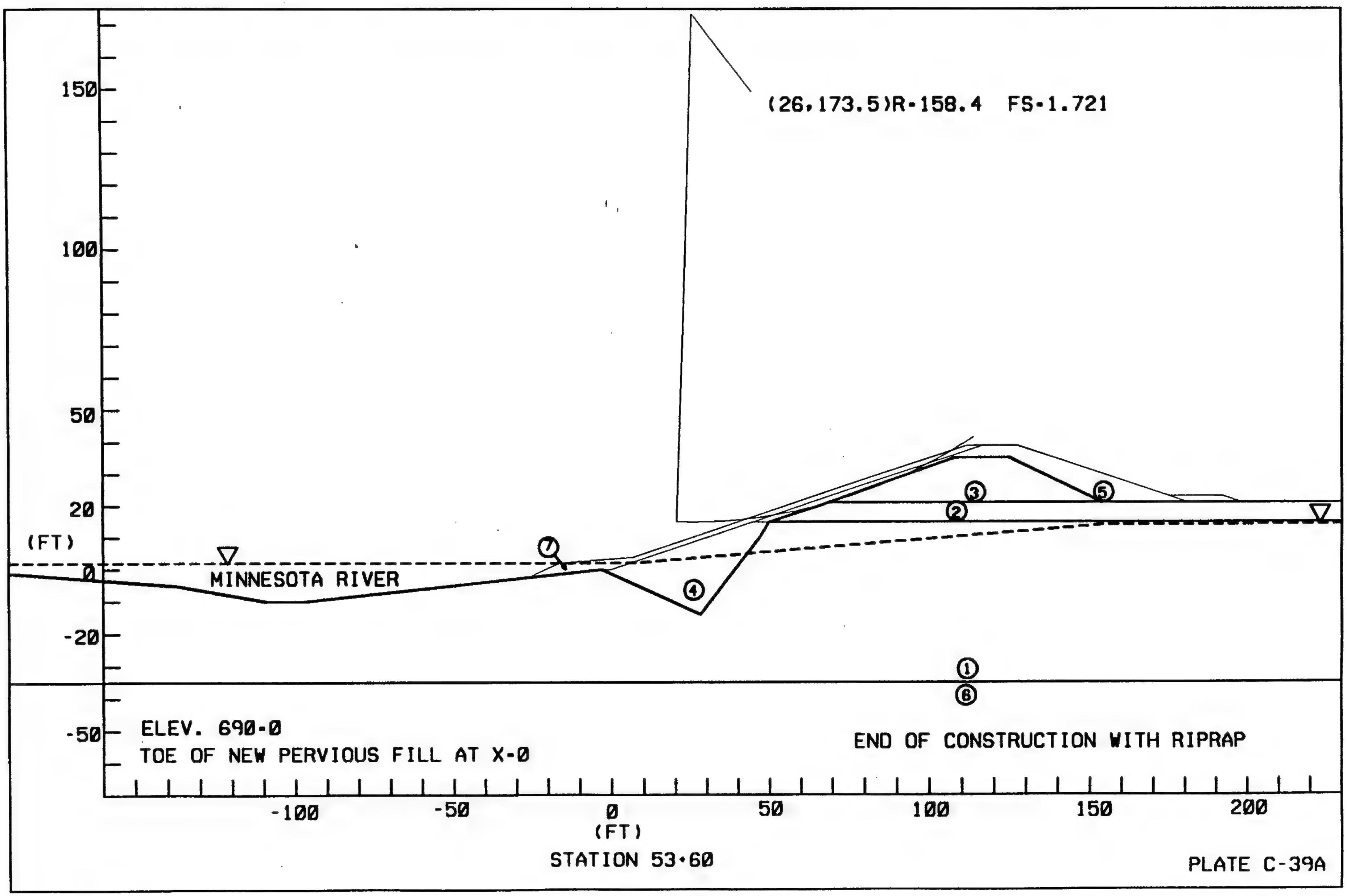
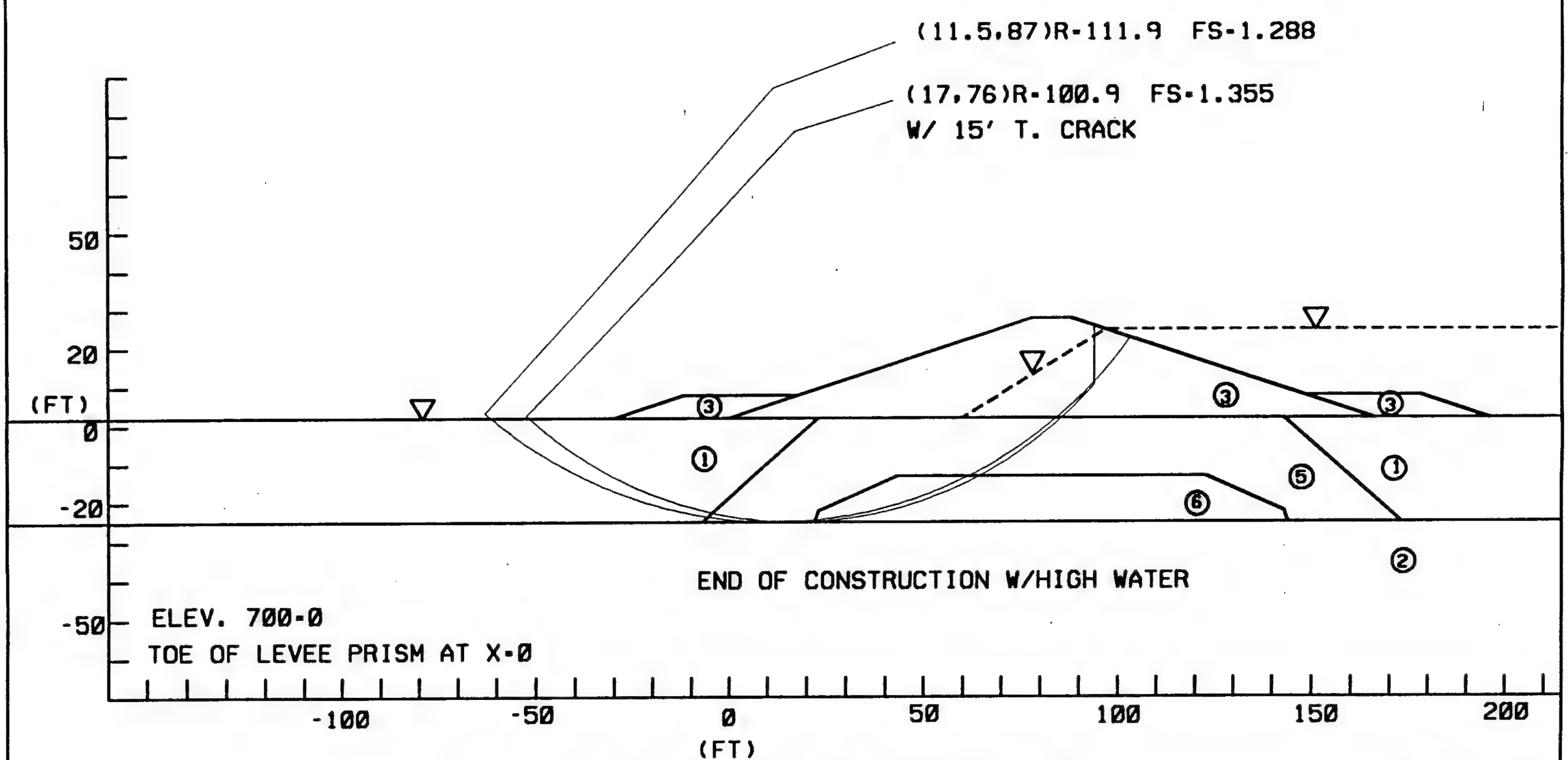

150
100
50
20
(FT)
0
-20
-50
(26,134.5)R=119.4 FS=1.636
MINNESOTA RIVER
ELEV. 690.0
TOE OF NEW PERVIOUS FILL AT X=0
END OF CONSTRUCTION WITHOUT RIPRAP
-100
-50
0
(FT)
50
100
150
200
STATION 53+60

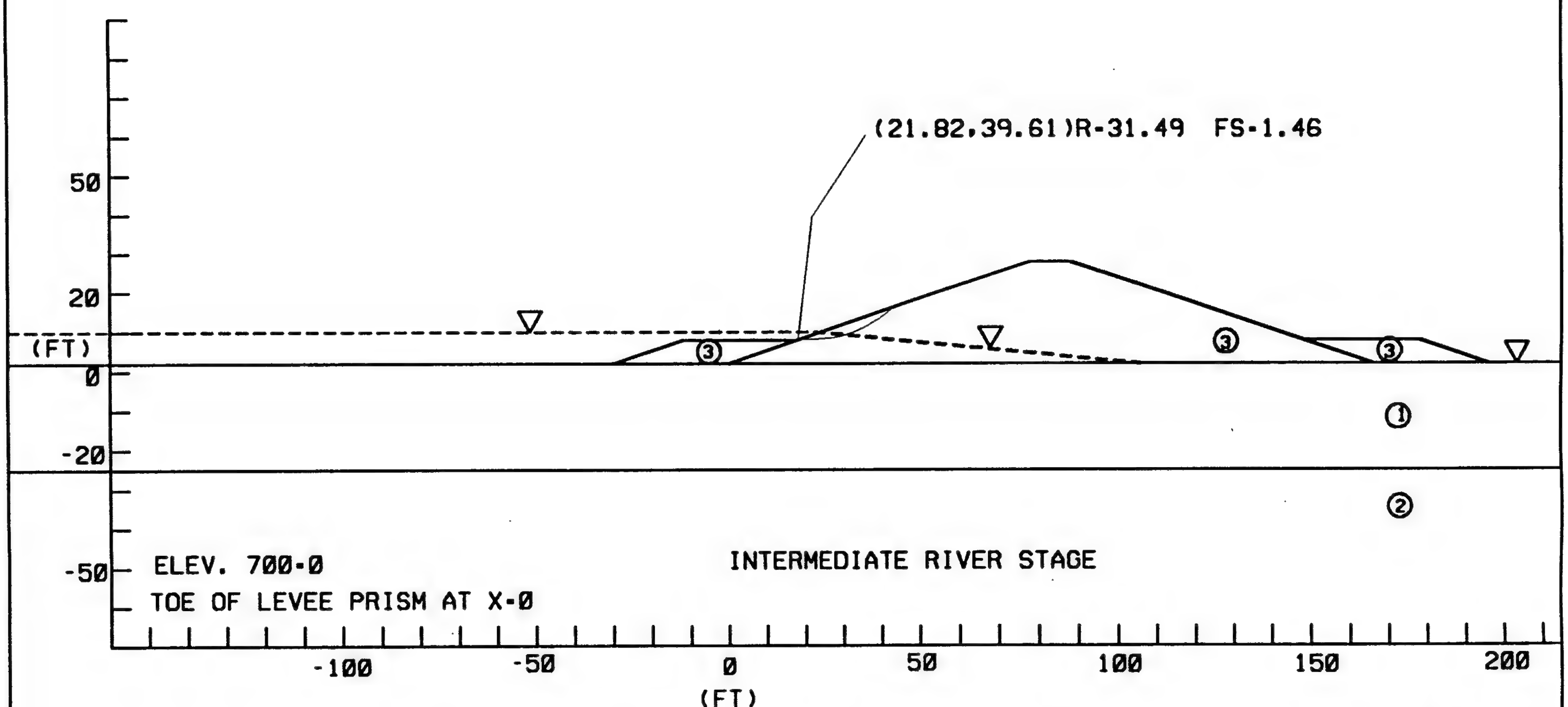
PLATE C-39


(26,173.5)R-158.4 FS-1.721
150
100
50
20
(FT)
0
-20
-50
MINNESOTA RIVER
ELEV. 690-0
TOE OF NEW PERVIOUS FILL AT X-0
END OF CONSTRUCTION WITH RIPRAP
-100
-50
0
(FT)
50
100
150
200
STATION 53+60
PLATE C-39A



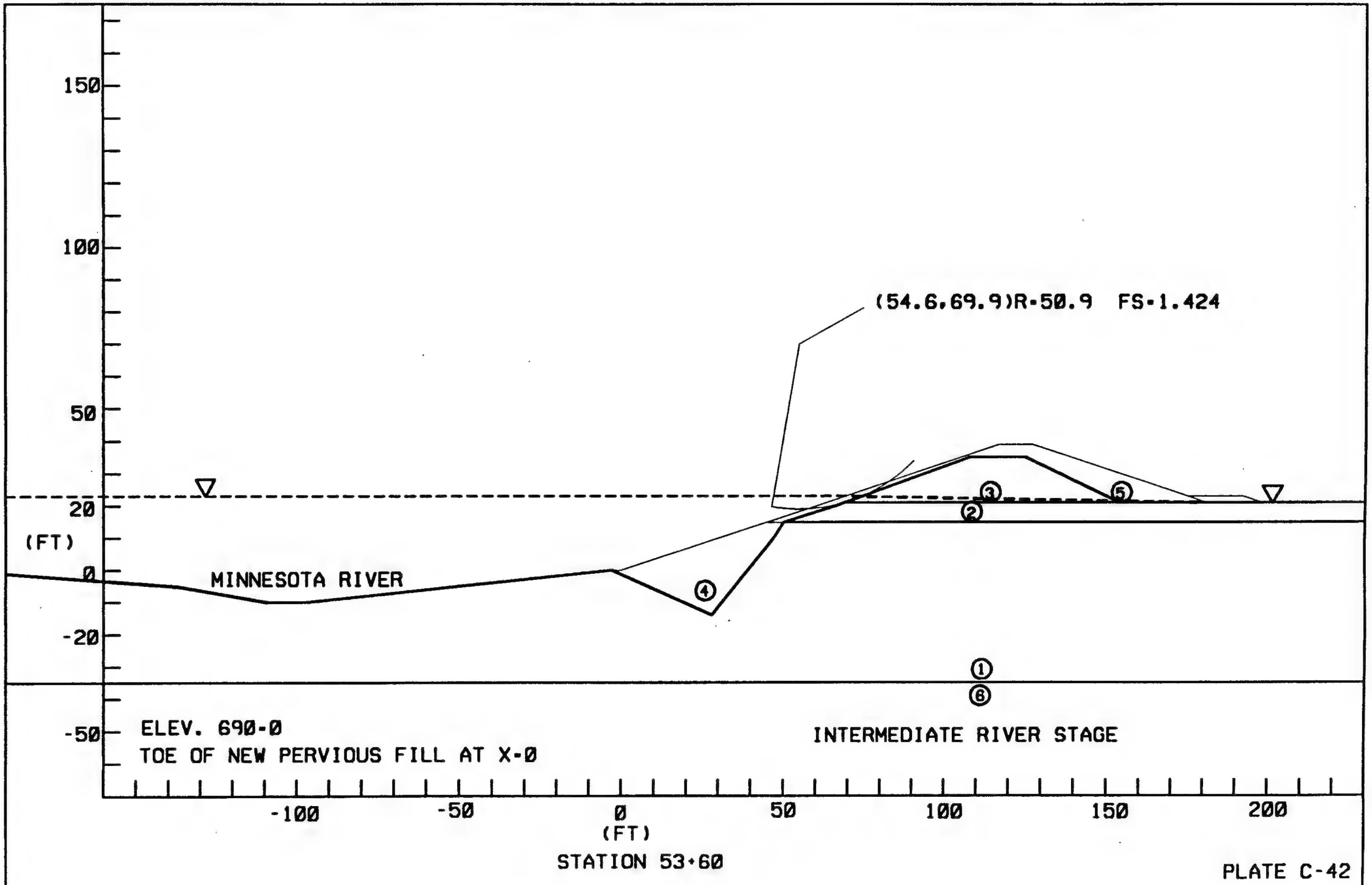
TYPICAL LEVEE SECTION EAST OF COURTHOUSE LAKE

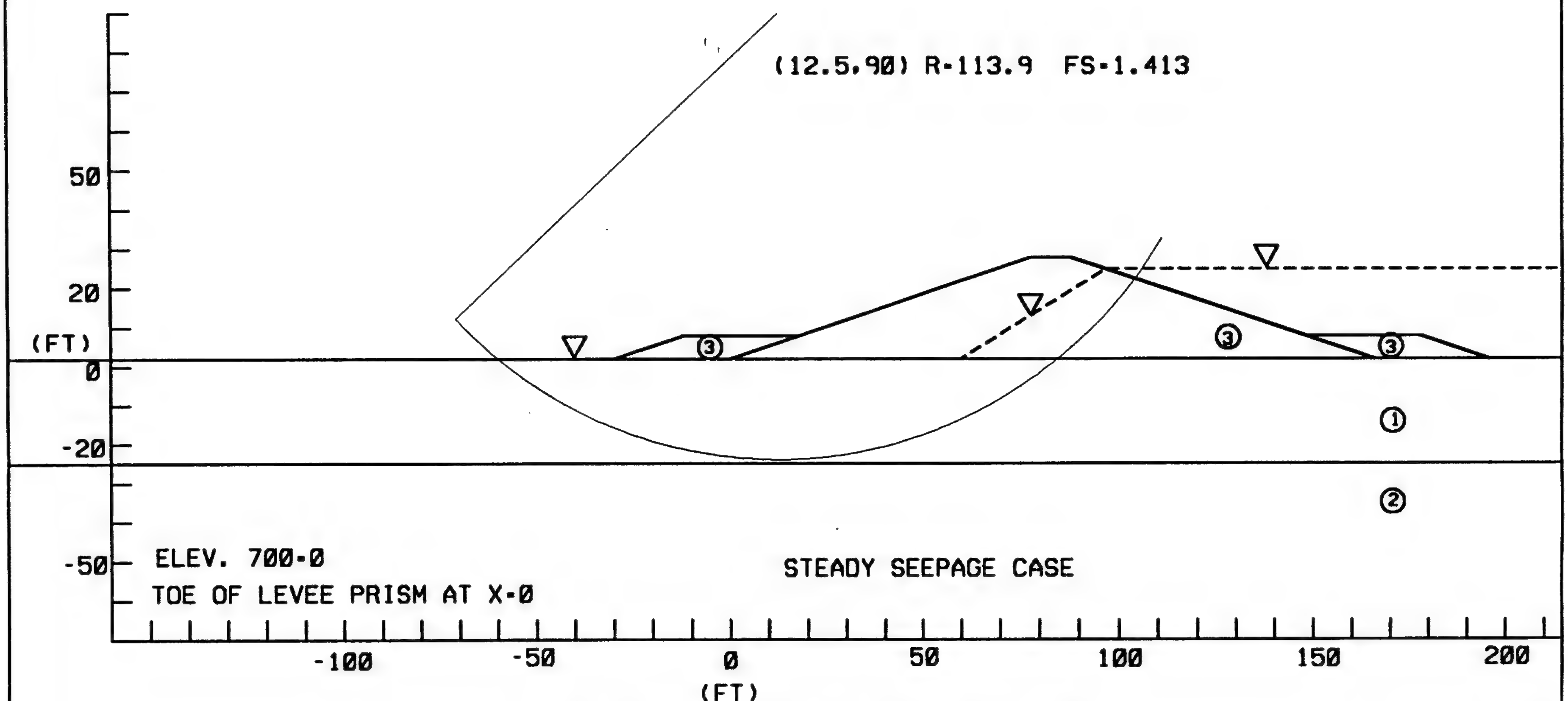
PLATE C-40



TYPICAL LEVEE SECTION EAST OF COURTHOUSE LAKE

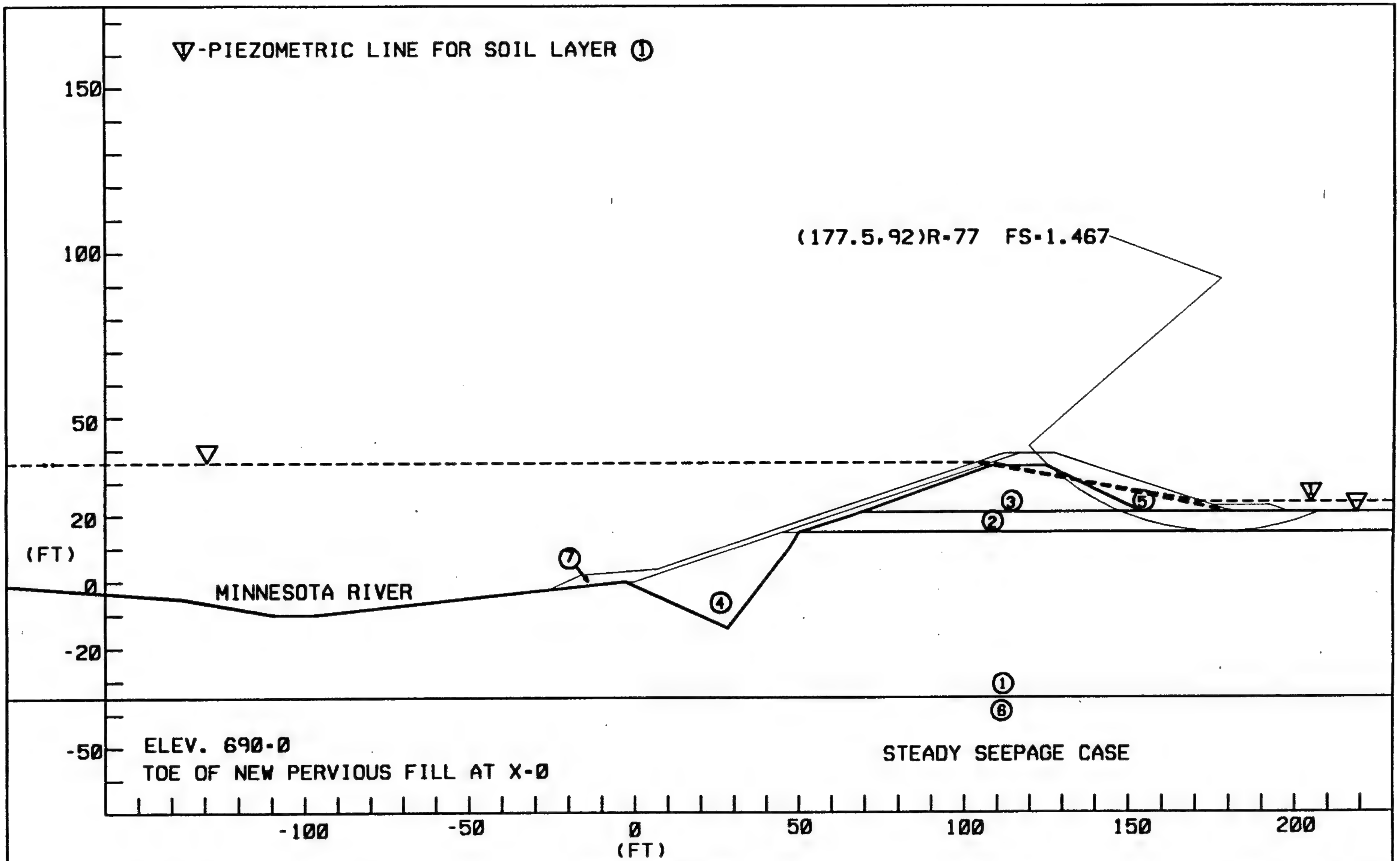
PLATE C-41


(54.6,69.9)R=50.9 FS=1.424
150
100
50
20
(FT)
0
-20
-50
MINNESOTA RIVER
ELEV. 690.0
TOE OF NEW PERVIOUS FILL AT X=0
INTERMEDIATE RIVER STAGE
-100
-50
0
(FT)
50
100
150
200
STATION 53+60
1
2
3
4
5
6
PLATE C-42



TYPICAL LEVEE SECTION EAST OF COURTHOUSE LAKE

PLATE C-43



∇-PIEZOMETRIC LINE FOR SOIL LAYER ①
(177.5,92)R=77 FS=1.467
150
100
50
20
(FT)
0
-20
-50
MINNESOTA RIVER
ELEV. 690.0
TOE OF NEW PERVIOUS FILL AT X=0
STEADY SEEPAGE CASE
-100
-50
0
(FT)
50
100
150
200
STATION 53+60

PLATE C-44

The following is a summary of the profile and piezometric lines used in the UTEXAS2 analyses adjacent to Courthouse Lake. The y-axis coordinate 0 is elavation 700 and the x-axis coordinate 0 is the levee prism toe.

LEVEE BY COURTHOUSE LAKE SLOPE STABILITY,end of 1st stage construction
check height of levee stable on soft soil, fill height=15'
PROFILE LINES
#1,soft native soils
-500,2;500,2
#2,dense native soils
-500,-25;500,-25
#3,levee fill
-30,2;15,17;151,17;196,2
PIEZOMETRIC LINE DATA
-500,0;500,0

LEVEE BY COURTHOUSE LAKE SLOPE STABILITY,staged construction
end of construction(2nd stage of staged construction)
PROFILE LINES
#1,soft native soils
-500,2;23,2
#1,soft native soils
143,2;500,2
#2,dense native soils
-500,-25;500,-25
#3,levee fill
-30,2;-12,8;18,8;78,28;88,28;148,8;196,2
#5,consolidated soft soils 1
-7,-25;3,-16;23,2;143,2;163,-16;173,-25
#6,consolidated soft soils 2
22,-25;23,-22;43,-13;123,-13;143,-22;144,-25
PIEZOMETRIC LINE DATA
-500,0;500,0

LEVEE BY COURTHOUSE LAKE SLOPE STABILITY,staged construction,2nd stage
end of construction,failure towards Courthouse Lake
PROFILE LINES
#1,soft native soils
-128,-15;-117,-10;-92,0;-88.4,2;-21,2;0,2;23,2
#1,soft native soils
143,2;500,2
#2,dense native soils
-500,-50;-267,-50;-212,-40;-167,-30;-139,-20;-128,-15;-25,-15;-20,-25;500,-25
#3,levee fill
-25.5,3.5;-12,8;18,8;78,28;88,28;148,8;196,2
#5,consolidated soft soils 1
-7,-25;3,-16;23,2;143,2;163,-16;173,-25
#6,consolidated soft soils 2
22,-25;23,-22;43,-13;123,-13;143,-22;144,-25
#2,dense native soils
-88.4,2;-74,10;-67,16;-49,15;-40,10;-30,5;-21,2
PIEZOMETRIC LINE DATA
-500,-50;-267,-50;-212,-40;-167,-30;-139,-20;-128,-15;-117,-10;-92,0;500,0

LEVEE BY COURTHOUSE LAKE SLOPE STABILITY,staged construction,2nd stage
end of construction with high water
PIEZOMETRIC LINE DATA
-500,2;0,2;60,2;97,25;500,25

LEVEE BY COURTHOUSE LAKE SLOPE STABILITY,staged construction,2nd stage
steady seepage case,final height at 728,water surface at 725
PIEZOMETRIC LINE DATA
-500,2;0,2;60,2;97,25;500,25

The following is a summary of the profile and piezometric lines used in the UTEXAS2 analyses at East Creek with a failure parallel to the levee alignment. The y-axis coordinate 0 is elevation 700 and the x-axis coordinate 0 is the levee prism toe.

LEVEE BY COURTHOUSE LAKE SLOPE STABILITY,end of 1st stage construction
failure parallel to levee at East Creek,fill height=15'
PROFILE LINES
#1,soft native soils
-500,2;-60,2;-50,-2;-34,-2;-24,2;500,2
#2,dense native soils
-500,-25;500,-25
#3,levee fill
0,2;60,17;500,17
PIEZOMETRIC LINE DATA
-500,0;-60,0;-50,-2;-34,-2;-24,0;500,0

LEVEE BY COURTHOUSE LAKE SLOPE STABILITY,staged construction,2nd stage
failure parallel to levee axis at East Creek crossing(1V to 4H levee slope)
PROFILE LINES
#1,soft native soils
-500,2;-60,2;-50,-2;-34,-2;-24,2;68,2
#2,dense native soils
-500,-25;500,-25
#3,levee fill
0,2;60,17;500,17
#5,consolidated soft soils 1
38,-25;48,-16;68,2;500,2
#6,consolidated soft soils 2
67,-25;68,-22;88,-13;500,-13
PIEZOMETRIC LINE DATA
-500,0;-60,0;-50,-2;-34,-2;-24,0;500,0

The following is a summary of the profile and piezometric lines used in the UTEXAS2 analyses at station 53+60. The y-axis coordinate 0 is elavation 690 and the x-axis coordinate 0 is the pervious fill in the river.

levee at 53+60(DM stationing);end of construction
elevation=690,riprap included
PROFILE LINES

#1,natural grade sand aquifer
-500,-1;-190,-1;-137,-5;-109,-10;-97,-10;-62,-5;-25,-1.9;-3,0;28,-14;47,10;
50,15;500,15
#2,natural grade sand top blanket
50,15;66,20;68.8,21;500,21
#3,existing grade,existing levee fill
68.8,21;108,35;125,35;154,21
#4,new fill pervious
-3,0;0,0;45,15;50,15
#5,new fill;impervious
45,15;117,39;127,39,181,21
#6,underlying harder strata
-500,-35;500,-35
#7,riprap,with 10' bench
-25,-1.9;-16.2,2;6.75,3.83;112.75,39;117,39
#4,new pervious fill,berm for wells
175,23;192,23;198,21
PIEZOMETRIC LINE DATA
-500,2;6,2;154,14;500,14

levee at 53+60(DM stationing);steady seepage case
elevation=690,riprap included,water surface at 726
PIEZOMETRIC LINE DATA
1 62.4 piezometric line for all but sand aquifer and top blanket
-500,36;103.75,36;108,36;181,21;500,21
2 62.4 piezometric line for sand aquifer
-500,36;103.75,36;108,36;172,24;500,24
INTERPOLATION DATA USED TO SET PORE PRESSURES IN TOP BLANKET

file:/usr2/jrc/chaska/STAGE4/seepage/alt/b73-1f.w20 SHALLOW AQUIFER

Project:Chaska,Stage 4 BORING EVALUATION SHEET FOR UPLIFT Date : 15-APR-1991

I BOTTOM ELEVATION OF BLANKET : 705.0
II BOTTOM ELEVATION OF AQUIFER : 665.2

Boring log 73-1M
710.0 Top Elev.

III BLANKET EVALUATION

Soil Unit	Elevation From	To	Thick (z act.)	Kv FPM	Trans. Factor	Zb	Zt	Moist Density	Zt x D	Kvr FPM	Trans. Factor	Zbr
			0.0			0	0.0		0.0	0	0	0
			0.0			0	0.0		0.0	0	0	0
			0.0			0	0.0		0.0	0	0	0
SM	709	708	1.0	0.002	0.4	0.4	1.0	62.6	62.6	0.0014	0.114	0.1
CL	708	705	3.0	0.0008	1	3	3.0	62.6	187.8	0.00016	1	3
Sum "z" =			4.0			3.4	4.0		250.4			3.1

Value of Kv to use in calculating X3 below: 0.0008 fpm

IV EVALUATION OF PERVIOUS AQUIFER

Soil Unit	Elevation From	To	Thick d	D10	Source D10	Kh	Kh x d	Remarks
SP-SM	705	694.3	10.7	0.08	G	0.02	0.214	
SM	694.3	690.5	3.8		A		0	
SP-SM	690.5	688	2.5	0.1	G	0.04	0.1	
SP	688	682	6.0	0.14	G	0.09	0.54	
ML	682	676.6	5.4		A		0	
SP	676.6	672.5	4.1	0.14	A	0.09	0.369	
SW-SM	672.5	665.2	7.3	0.095	G	0.04	0.292	
CL	665.2	664	0.0		A		0	

Sum [d] = 39.8 Sum [Kh x d] = 1.5

Source : "G" = Gradation, "P" = Permeability Test, "A" = Assumed

Kf = (sum [Kh x d])/(sum [d]) = 0.038 fpm

EQUIVALENT BLANKET LENGTH (X3) (see note below)

(B-3) X3 = [(Kf*d*Zb)/(Kb)]^0.5 = 80.24 ft.

Note: Depending on boundary conditions "X3" may be defined differently.

Boring log scale (elevation / depth): 710.0 / 0; 700 / 10; 690 / 20; 680 / 30; 670 / 40; 660 / 50

file:/usr2/jrc/chaska/STAGE4/seepage/alt/s73-1f.w20

```
              MATHEMATICAL ANALYSIS OF UNDERSEEPAGE
                    AND SUBSTRATUM PRESSURE                 15-APR-1991

              From Appendix B of "EM 1110-2-1913" & "TM 3-424"

 Note : The data from boring evaluation sheet "   73-1M " riverside
        and "    73-1M " Landside has been transfered to this spreadsheet.

 Case 7, Semipervious Top Stratum Both Riverside and Landside.
-----------------------------------------------------------------------------
 Input from Boring Evaluation Sheet and cross-section.

  Kf =     0.038. fpm of pervious substratum
  Kbl =   0.0008 fpm
  Kbr =  0.00016 fpm            Riverside cR =  [(Kbr)/(Kf*Zbr*d)]^.5
  Zbl =      3.4 ft.               "c"    cR =   0.00584
  Zbr =      3.1 ft.            Landside  cL =  [(Kbl)/(Kf*Zbl*d)]^.5
   d =      39.8 ft.               "c"    cL =   0.01247
  L1 =        25 ft.
  L2 =     131.2 ft.    (cR*L1)= 0.14604   tanh(cRL1) =  0.14502
  L3 =      1000 ft.    (cL*L3)=  12.473   tanh(cLL3) =        1
 Top of levee =    729.2
 Flood elev.  =    726.2  Uplift head =     20.2 ft.
 Base of levee =  709.00  Seepage "H" =     17.2 ft.
-----------------------------------------------------------------------------
Determine distance from Landside Levee Toe to Effective Seepage Exit, x3.
        For L3 = infinity
(B-3)   x3 = 1/cL = [(Kf*Zbl*d)/(Kbl)]^.5
          x3 =      80.2 ft.

        For L3 = finite distance to a seepage block
(B-4)   x3 = 1/(cL*tanh(cLL3))
          x3 =      80.2 ft.

        For L3 = finite dist. to an open seepage exit.
(B-5)   x3 = (tanh(cLL3))/cL
          x3 =      80.2 ft.

 Determine distance from Effective Source Seepage Entry To Riverside Levee Toe, x1.

(B-7)   x1 = (tanh(cRL1))/cR    L1 is known and No seepage blocks or pits exist.
          x1 =      24.8 ft.
(B-8)   x1 = 1/(cR*tanh(cRL1))  Seepage block exists.
          x1 =    1180.4 ft.
-----------------------------------------------------------------------------
Case 7.     d =    39.8    x1 =    24.8    L2 =   131.2    x3 =    80.2
 Shape factor "$" = d/(x1+L2+x3)    =     0.1685
  Uplift Head  =  ho  =  H*(x3/(x1+L2+x3))  =        6.9 ft
Input resisting soil wt. from Boring log sheet.
 Wt. =    250.4 psf =       4.0 ft. of water

                              4.0
  Factor of Safety =   --------      =       0.59  Min. F.S. > 1.5
                              6.9                 *Berm Required*

  Calculate seepage per ft of levee.    Check Uplift Gradient
   Qs = ($)(Kf)(H)                      Io = ho/Zt  Zt =       4 ft.
   Qs =    0.110 ft^3/min/ft.             Io =      1.71
   Qs =    0.824 gpm/ft.

*Berm Required*
*No Berm Required*
```

file:/usr2/jrc/chaska/STAGE4/seepage/alt/m73-1f.w20

15-APR-1991

SEEPAGE BERM DESIGN - EM 1110-2-1913

```
  i0 =     0.5       Allowable gradient at levee toe
  i1 =     0.8       Allowable gradient at berm toe
  x1 =    24.8 ft.  Distance to seepage entrance from riverside levee toe
  x3 =    80.2 ft.  Distance to seepage exit from landside levee toe
  L2 =   131.2 ft.  Levee width
  ho =     6.9 ft.  Head at landside toe of levee without berm
  H  =    20.2 ft.  Total net head on levee
  Kf =   0.038 fpm  Permeability of pervious substratum
 Kbl =  0.0008 fpm  Permeability of landside top stratum
 Zbl =     3.4 ft.  Transformed thickness of landside top stratum
  Zt =       4 ft.  Actual thickness of landside top stratum
  D  =    39.8 ft.  Effective thickness of pervious substratum
  Yt =    52.5 pcf  Submerged unit weight of berm, impervious & semipervious
  Yt =    57.5 pcf  Submerged unit weight of berm, sand & pervious
  Yz =    62.5 pcf  Submerged unit weight of top stratum
  r  =   0.625       i0/i1
  c  = 0.01247       [(Kbl)/(Kf*Zbl*d)]^0.5
  s  =     156 ft.  x1+L2 = dist. to effective seepage entrance from levee toe
  A  =    15.5       6 + 3sc(r+1)
  ha =     3.2 ft.  allowable head at toe of berm = i1*Zt
-----------------------------------------------------------------------
 Calculate required berm width, "Xsp" semipervious berm
 Xsp =    88.2 ft.  (-A+[A^2-24*(2+r)*(1+s*c-(H/ha))]^.5)/(2c*(2+r))
 Calculate head at landside toe of levee with berm
 h'o =     8.4 ft.  ha*[1+c*(Xsp)+((2+r)/6)(c*(Xsp))^2]
 Calculate required thickness of berm
  t  =     4.3 ft.  (h'o - i0*Zt)/(1+i0)
-----------------------------------------------------------------------
 Calculate required berm for: "Xp" pervious berm with collector
  Xp =    61.6 ft.  x3*log(e)(h'o/ha)   h'o=ho
 h'o =     6.9 ft.   = ho = (H*x3)/(s+x3)
  t  =     2.8 ft.  [h'o-Zt(Y'z/F*Yw)]/[1+(Y't/F*Yw)     F = 1.6
  Qb =   0.069 cfm  [(Kf*H*d)/(s+x3)]*[1-EXP(-Xp/x3)]
  Qb =    0.52 gpm   flow per ft. of levee
-----------------------------------------------------------------------
 Calculate required berm for: "Xs" sand berm
  Xs =    79.3 ft.  (1/3)*(Xp+2Xsp)
 h'o =     7.7 ft.  ha*[1+c*Xs+(2+r)/6*(c*Xs)^2]
  t  =     3.3 ft.  [h'o-Zt*(Y'z/F*Yw)]/(1+(Y't/F*Yw))
-----------------------------------------------------------------------
 Calculate required berm for: "XI" Impervious berm
  XI =   270.1 ft.   x3*[(H/ha)-1]-s
 h'o =    14.0 ft.   H*[(x3+XI)/(s+x3+XI)]
  t  =     7.5 ft.   [h'o-Zt*(Y'z/F*Yw)]/(1+(Y't/F*Yw))
-----------------------------------------------------------------------
```

type of Berm	Width	t	h'o	Thick Berm Crown	Design Slope 1 On	Thick Levee Toe	25 % increase in size Berm Crown	Levee Toe	cu. yd. per 100'	Const. Slope 1 on
Imper	270	7.5	14.0	2.0	75	7.5	2.50	9.4	6,441	39
Semip	88	4.3	8.4	2.0	75	4.3	2.50	5.3	1,439	31
Sand	79	3.3	7.7	2.0	75	3.3	2.50	4.1	1,072	48
P w/C	62	2.8	6.9	2.0	75	2.8	2.50	3.5	757	60

CHASKA STAGE 4,/USR/jrc/chaska/STAGE4/WELLAT706/w73-1f
741-SF-F5050 DESIGN FOR INFINITE SYSTEM OF RELIEF WELLS
WELL DESIGN, RISer at 706
54+00
8" WELL

D	FK	X3	S	H	WHT	RL
39.800	0.038	80.200	156.000	20.200	-3.000	2.750

DIA	RW	FREE	WD1	CODE	SAFE	F
8.000	0.530	3.000	0.000	0.000	1.000	1.700

LAYER	ZT(I)	GAM(I)
1	4.000	125.000

FS= 0.585

WD	SP	QW R	V HW	HAV HAV1	TAV TAV1	QUEW QSW	QS	HM1 HAVB	TM1 TM
0.400	47.085	51.	0.328	1.744	1.028	0.980	1.156	5.292	1.164
		115.	-2.931	4.676	1.028	0.177		1.254	1.164
0.500	53.807	60.	0.384	1.623	0.857	1.003	1.164	5.295	0.996
		112.	-2.935	4.558	0.857	0.162		1.145	0.996
0.600	60.183	68.	0.436	1.547	0.743	1.017	1.169	5.298	0.878
		110.	-2.937	4.484	0.743	0.152		1.076	0.878
0.700	66.263	76.	0.485	1.496	0.661	1.027	1.173	5.299	0.790
		109.	-2.939	4.435	0.661	0.145		1.031	0.790
0.800	72.085	83.	0.531	1.462	0.599	1.034	1.175	5.300	0.722
		109.	-2.940	4.402	0.599	0.141		1.000	0.722
0.900	77.675	90.	0.574	1.439	0.551	1.038	1.176	5.301	0.667
		108.	-2.940	4.379	0.551	0.138		0.979	0.667
1.000	83.057	96.	0.616	1.423	0.512	1.041	1.177	5.301	0.622
		108.	-2.941	4.363	0.512	0.136		0.965	0.622

file:/usr2/jrc/chaska/STAGE4/well/T73-1f.w20
15-APR-1991
pg.293 of TM3-424

W-effective screen penetration in a stratified foundation
W|-well screen length
dn-thickness of nth soil layer
kh_n-horizontal permeability of nth soil layer
kv_n-vertical permeability of nth soil layer
d|n-transformed isotropic thickness of nth soil layer
k|n-transformed isotopic permeability of nth soil layer
D|-thickness of transformed,homogeneous, isotropic foundation
K|-effective permeability of transformed foundation

d|n=dn*sqrt(kh_n/kv_n)

k|n=sqrt(kh_n*kv_n)

D|=sqrt(sum(dn*kh_n)*sum(dn/kv_n))

K|=sqrt(sum(dn*kh_n)/sum(dn/kv_n))

W=sum(from 0 to W|)(dn*kh_n)/K|

WP=well screen penetration into layer(100%=1;50%=.5;etc.)

W/D|={[sum(WP*dn*kh_n)]/[sum(dn*kh_n)]}

# of soil layers n	thickness of soil layers dn	kh_n	kv_n	d|n	k|n	dn*kh_n	dn/kv_n	WP	WP* dn*kh_n	
1	10.7	0.02	0.02	10.7	0.02	0.214	535	0.8	0.179	8.95
2	3.8	0	0		0	0		1	0	3.8
3	2.5	0.04	0.04	2.5	0.04	0.1	62.5	1	0.1	2.5
4	6	0.09	0.09	6	0.09	0.54	66.6667	1	0.54	6
5	5.4	0	0		0	0		1	0	5.4
6	4.1	0.09	0.09	4.1	0.09	0.369	45.5556	1	0.369	4.1
7	7.3	0.04	0.04	7.3	0.04	0.292	182.5	1	0.292	7.3
8	0	0	0		0	0		0	0	0
9	0	0	0		0	0		0	0	0
10	0	0	0		0	0		0	0	0
11	0	0	0		0	0		0	0	0
12	0	0	0		0	0		0	0	0
13	0	0	0		0	0		0	0	0
14	0	0	0		0	0		0	0	0
15	0	0	0		0	0		0	0	0
16	0	0	0		0	0		0	0	0
	39.8				sums=	1.515	892.222		1.48	38.05 screen length

D|= 36.7657
K|= 0.04121

W/D|= 0.9769
(W/D|)%= 97.6898

file:/usr2/jrc/chaska/STAGE4/seepage/alt/b73-1f1.w20 DEEP AQUIFER

Project:Chaska,Stage 4 BORING EVALUATION SHEET FOR UPLIFT Date : 15-APR-1991

I BOTTOM ELEVATION OF BLANKET : 664.0
II BOTTOM ELEVATION OF AQUIFER : 576.0

Boring log 73-1M
710.0 Top Elev.

Elev.	Depth
710.0	0
700	10
690	20
680	30
670	40
660	50
650	60
640	70
630	80
620	90

III BLANKET EVALUATION

Soil Unit	Elevation From -	To	Thick (z act.)	Kv FPM	Trans. Factor	Zb	Zt	Moist Density	Zt x D	Kvr FPM	Trans. Factor	Zbr
SM	709	708	1.0	0.002	0.4	0.4	1.0	62.6	62.6	0.0014	0.114	0.1
CL	708	705	3.0	0.0008	1	3	3.0	62.6	187.8	0.00016	1	3
SP-SM	705	694.3	10.7	0.02	0.04	0.428	10.7	62.6	669.8	0.02	0.008	0.1
SM	694.3	690.5	3.8	0.002	0.4	1.52	3.8	62.6	237.9	0.0014	0.114	0.4
SP-SM	690.5	688	2.5	0.04	0.02	0.05	2.5	62.6	156.5	0.04	0.004	0
SP	688	682	6.0	0.09	0.009	0.053	6.0	62.6	375.6	0.09	0.002	0
ML	682	676.6	5.4	0.0016	0.5	2.7	5.4	62.6	338.0	0.0003	0.533	2.9
SP	676.6	672.5	4.1	0.09	0.009	0.036	4.1	62.6	256.7	0.09	0.002	0
SW-SM	672.5	665.2	7.3	0.04	0.02	0.146	7.3	62.6	457.0	0.04	0.004	0
CL	665.2	664	1.2	0.0008	1	1.2	1.2	62.6	75.1	0.00016	1	1.2
Sum "z" =			45.0			9.5	45.0		2817.0			7.8

Value of Kv to use in calculating X3 below: 0.0008 fpm

IV EVALUATION OF PERVIOUS AQUIFER

Soil Unit	Elevation From -	To	Thick d	D10	Source D10	Kh	Kh x d	Remarks
SP-SM	664	644.5	19.5	0.12	G	0.08	1.56	
SP-SM	644.5	626	18.5	0.17	G	0.14	2.59	
GP	626	607	19.0	0.21	G	0.22	4.18	
SP	607	598	9.0	0.19	G	0.18	1.62	
SP	598	576	22.0	0.12	G	0.08	1.76	
CL-CH	576	574	0.0		A		0	
SP	567.7	558	0.0		A		0	

Sum [d] = 88.0 Sum [Kh x d] = 11.7
Source : "G" = Gradation, "P" = Permeability Test, "A" = Assumed
Kf = (sum [Kh x d])/(sum [d]) = 0.133 fpm

EQUIVALENT BLANKET LENGTH (X3) (see note below)

(B-3) X3 = [(Kf*d*Zb)/(Kb)]^0.5 = 373.6 ft.

Note: Depending on boundary conditions "X3" may be defined differently.

file:/usr2/jrc/chaska/STAGE4/seepage/alt/s73-1f1.w20

MATHEMATICAL ANALYSIS OF UNDERSEEPAGE
AND SUBSTRATUM PRESSURE 15-APR-1991

From Appendix B of "EM 1110-2-1913" & "TM 3-424"

Note : The data from boring evaluation sheet " 73-1M " riverside
and " 73-1M " Landside has been transfered to this spreadsheet.

Case 7, Semipervious Top Stratum Both Riverside and Landside.

Input from Boring Evaluation Sheet and cross-section.

```
 Kf =     0.133 fpm of pervious substratum
 Kbl =   0.0008 fpm
 Kbr =  0.00016 fpm           Riverside cR =  [(Kbr)/(Kf*Zbr*d)]^.5
 Zbl =      9.5 ft.                "c"    cR =   0.00132
 Zbr =      7.8 ft.           Landside  cL =  [(Kbl)/(Kf*Zbl*d)]^.5
  d =        88 ft.                "c"    cL =   0.00268
 L1 =        25 ft.
 L2 =     131.2 ft.    (cR*L1)=  0.0331    tanh(cRL1) =  0.03308
 L3 =      1000 ft.    (cL*L3)= 2.68235    tanh(cLL3) =  0.99069
Top of levee =     729.2
Flood elev.  =     726.2  Uplift head =     20.2 ft.
Base of levee =  709.00  Seepage "H" =     17.2 ft.
```

Determine distance from Landside Levee Toe to Effective Seepage Exit, x3.

```
        For L3 = infinity
(B-3)   x3 = 1/cL = [(Kf*Zbl*d)/(Kbl)]^.5
          x3 =      372.8 ft.

        For L3 = finite distance to a seepage block
(B-4)   x3 = 1/(cL*tanh(cLL3))
          x3 =      376.3 ft.

        For L3 = finite dist. to an open seepage exit.
(B-5)   x3 = (tanh(cLL3))/cL
          x3 =      369.3 ft.
```

Determine distance from Effective Source Seepage Entry To Riverside Levee Toe, x1.

```
(B-7)   x1 = (tanh(cRL1))/cR    L1 is known and No seepage blocks or pits exist.
          x1 =       25.0 ft.
(B-8)   x1 = 1/(cR*tanh(cRL1))  Seepage block exists.
          x1 =    22831.1 ft.
```

```
Case 7.     d =      88    x1 =     25.0    L2 =    131.2    x3 =    372.8
 Shape factor "$" = d/(x1+L2+x3)     =     0.16635
   Uplift Head  =  ho  =  H*(x3/(x1+L2+x3))  =       14.2 ft
Input resisting soil wt. from Boring log sheet.
  Wt. =     2817 psf =      45.1 ft. of water

                              45.1
   Factor of Safety =     --------     =        3.17   Min. F.S. > 1.5
                              14.2                   *No Berm Required*

  Calculate seepage per ft of levee.     Check Uplift Gradient
   Qs = ($)(Kf)(H)                       Io = ho/Zt  Zt =       45 ft.
   Qs =    0.381 ft^3/min/ft.              Io =      0.32
   Qs =    2.846 gpm/ft.

*Berm Required*
*No Berm Required*
```

File for future use

31 May 1973

CHASKA FLOOD CONTROL

SUMMARY

LIMITS AND MOISTURE CONTENTS

Request #73-11
(NCS-SA-73-72-EDF)

Sample No. and Lab. No.	Depth (ft)	Moisture Content %	Limits	
			Liquid	Plastic
		Hole No. 73-1M		
10/3Y-59	32.0-33.0	17.5	14	14
		Hole No. 73-2M		
3/3Y-67	6.5-7.0	53.8	74	31
6/3Y-68	18.0-18.5	67.3	85	29
12/3Y-69	38.0-38.5	26.8	38	19
		Hole No. 73-3M		
3/3Y-70	9.5-10.0	65.3	82	30
6/3Y-71	23.0-23.5	26.9	38	17
8/3Y-72	30.0-30.5	25.0	27	21
12/3Y-73	48.0-48.5	22.6	21	21
		Hole No. 73-7M		
9/3Y-81	37.0-39.5	23.7	33	18
		Hole No. 73-9M		
5/3Y-83	22.0-24.5	25.7	38	16

N.C.D. LAB.

incl 2

Figure C-1

May 1973

VISUAL CLASSIFICATION

REQUEST NR. 73-11

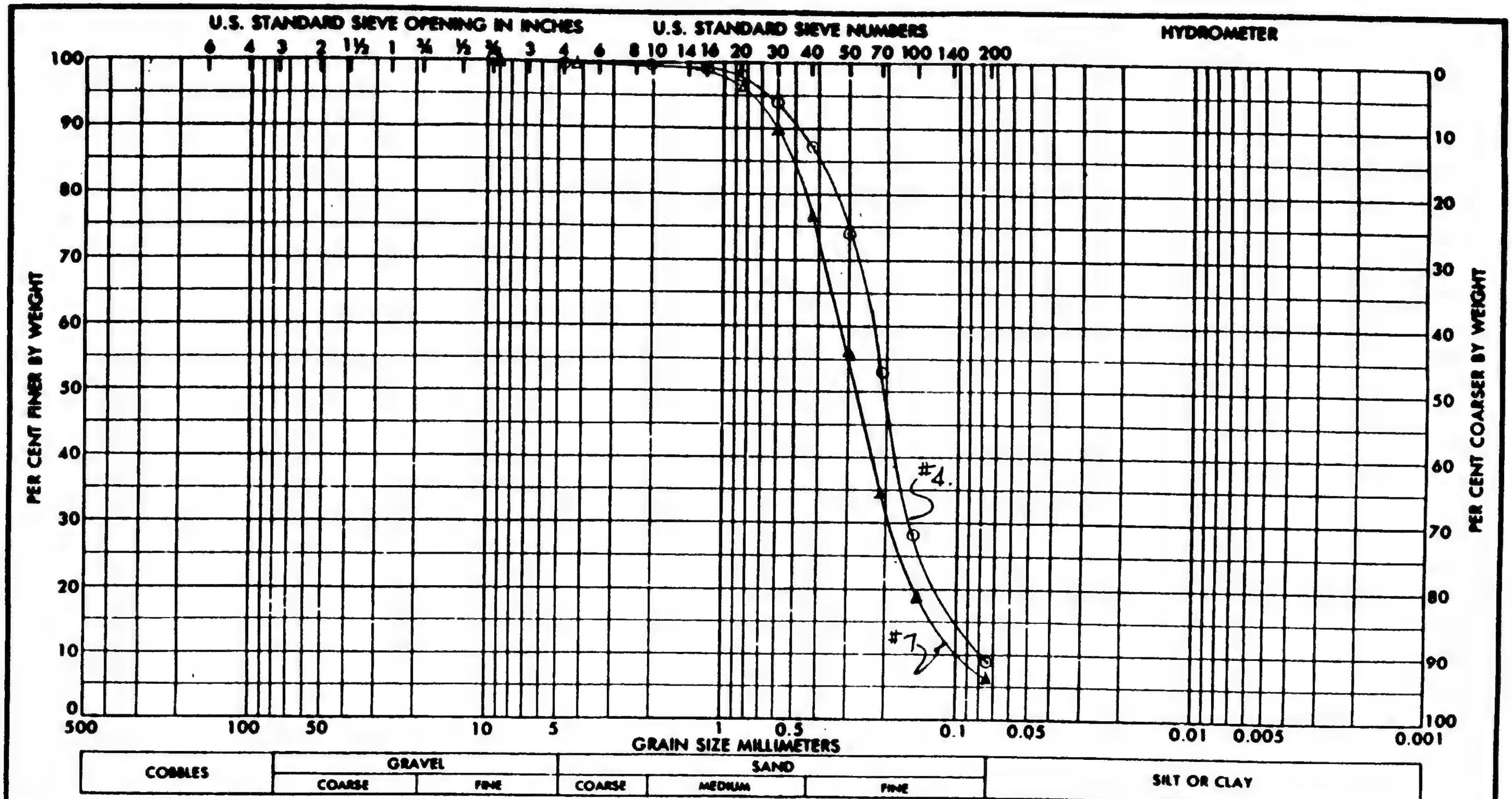
PROJECT: Chaska Flood Control

SITE:

HOLE NR	SAMPLE NR	DEPTH (FT)	ESTIMATED PERCENT MAX SIZE	GRAVEL	SAND	FINE	CLASSIFICATION	SYMBOL	DESCRIPTION	M.C.
73-4M	2	4.5-6.0	1/2	8	77	15	Silty Sand	SM	Brown, trace fine gravel; fine w/ med.-coarse sand; non-plastic	10.7
	3	9.5-11.0	1"	2	83	15	Silty Sand	SM	Brown; trace coarse & fine gravel; fine w/trace med.-coarse sand; non-plastic; trace coarse & fine wood chips	14.3
73-7M	3	7.0-9.5	#40	0	5	95	Silt	ML	Light brownish gray; trace fine sand; non-plastic; w/some lumps of clay	23.9
	5	17.0-19.5	#40	0	1	99	Clay	CL	Gray; trace fine sand; low plasticity; w/some silty areas	20.6

ECD FORM 70 SEP 68 24a (Previous editions are obsolete)

Figure C-



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4/3Y56	12.0'-13.0'	SILTY SAND (SM-SP.)	o	VISUAL		
7/3Y57	20.0'-21.0'	SAND (SP-SM.)	▲		"	

GRADATION CURVES

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO 73-1M.-

DATE MAY '73

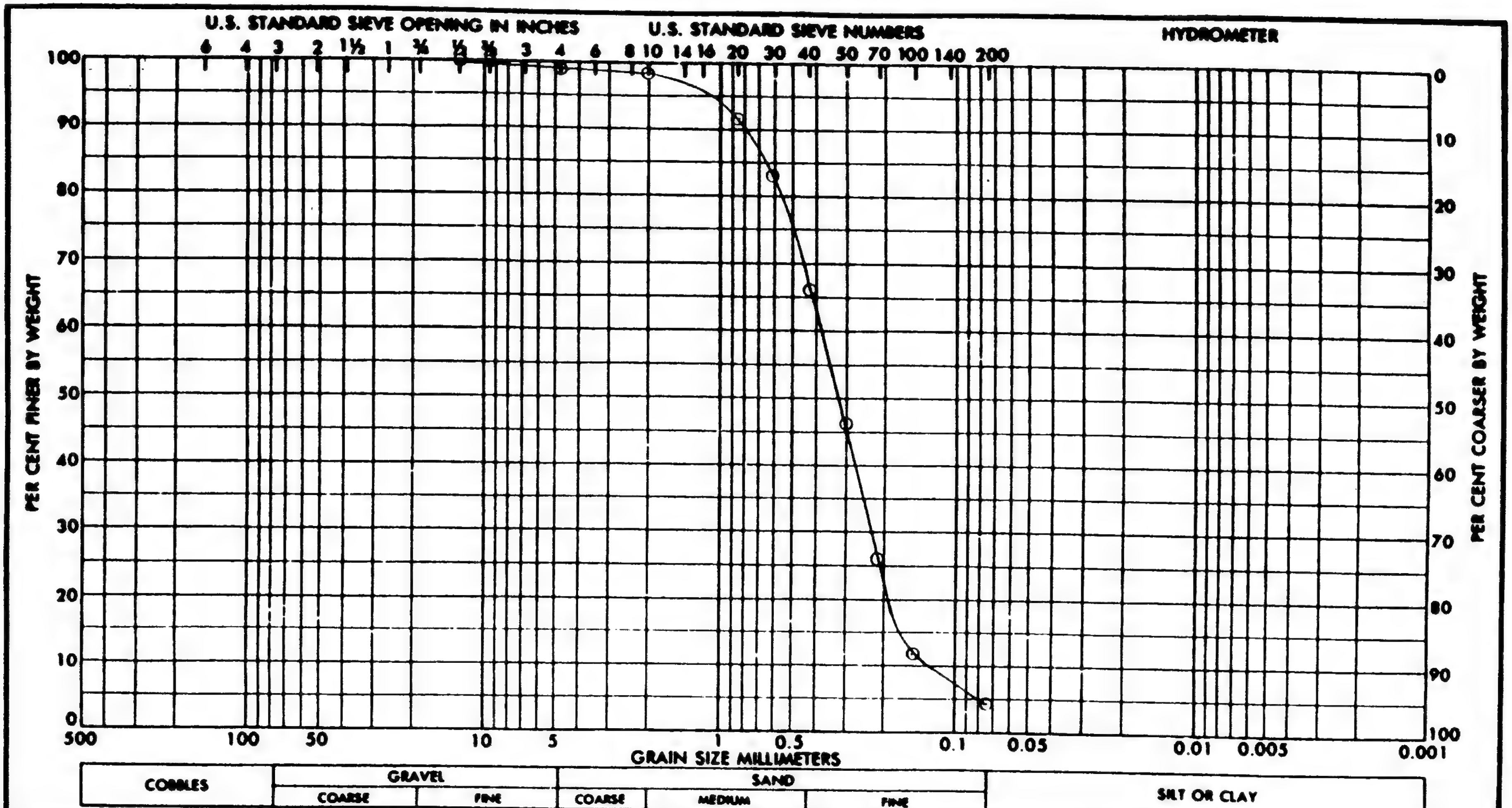
N.C.D. LAB.

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U S GOVERNMENT PRINTING OFFICE 1963 OF—700-120

Figure C-



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
8/3Y58	25.0'-26.0'	SAND (SP)	-	VISUAL.		

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO 73-1M.

DATE MAY. '73

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

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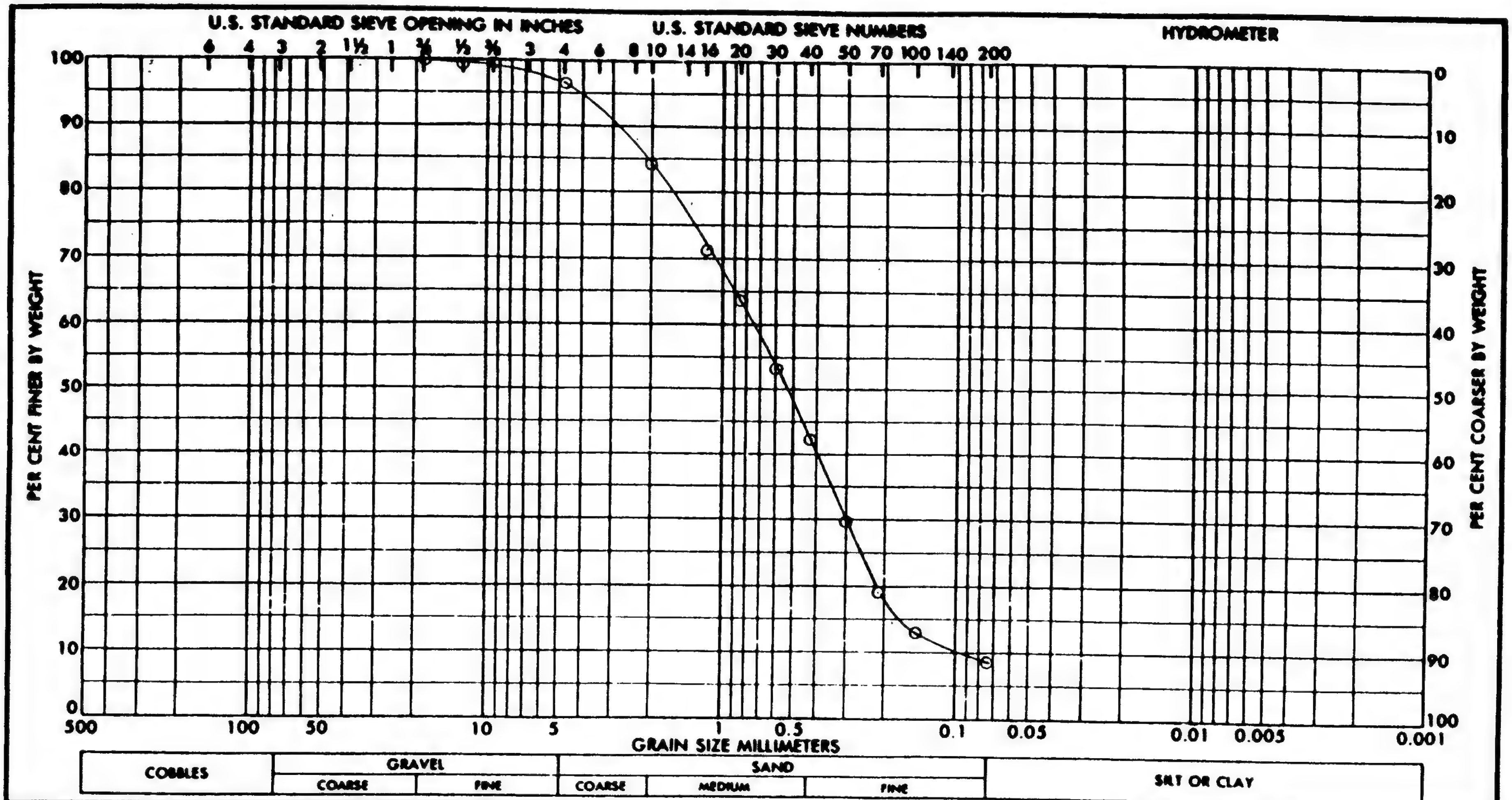
N.C.D. [illegible]

Figure C



SAMPLE NO.	~~ELEV~~ OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
12/3YGO	37.5'-38.5'	SILTY SAND (SM-SW.)		Visual		

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO 73-1M

DATE MAY 73

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

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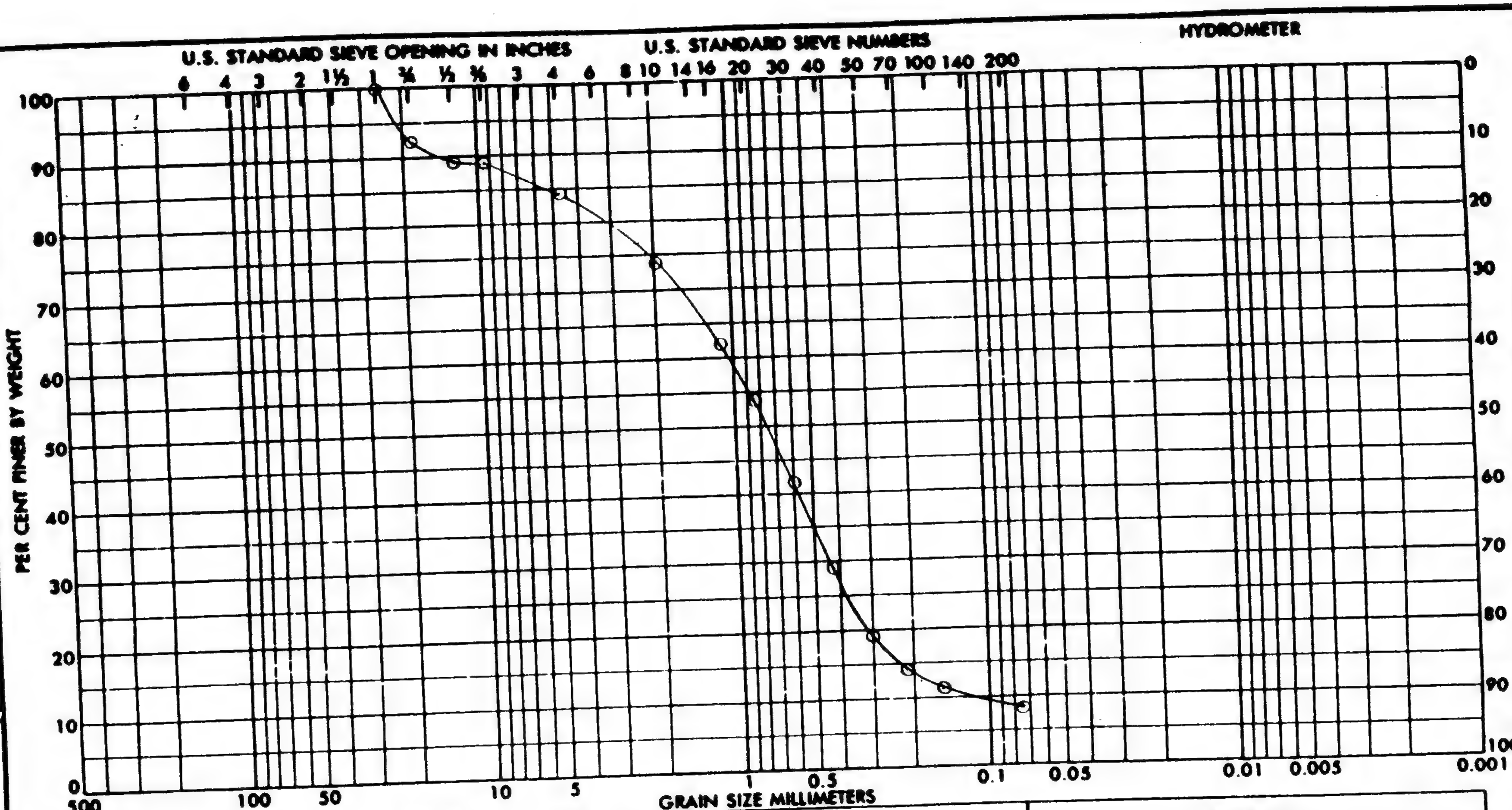
Figure C-5



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
17/3YG1	57.5'-58.5'	SILTY SAND, GRAVELLY (SM-SW)		VISUAL		

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO 73-1M.

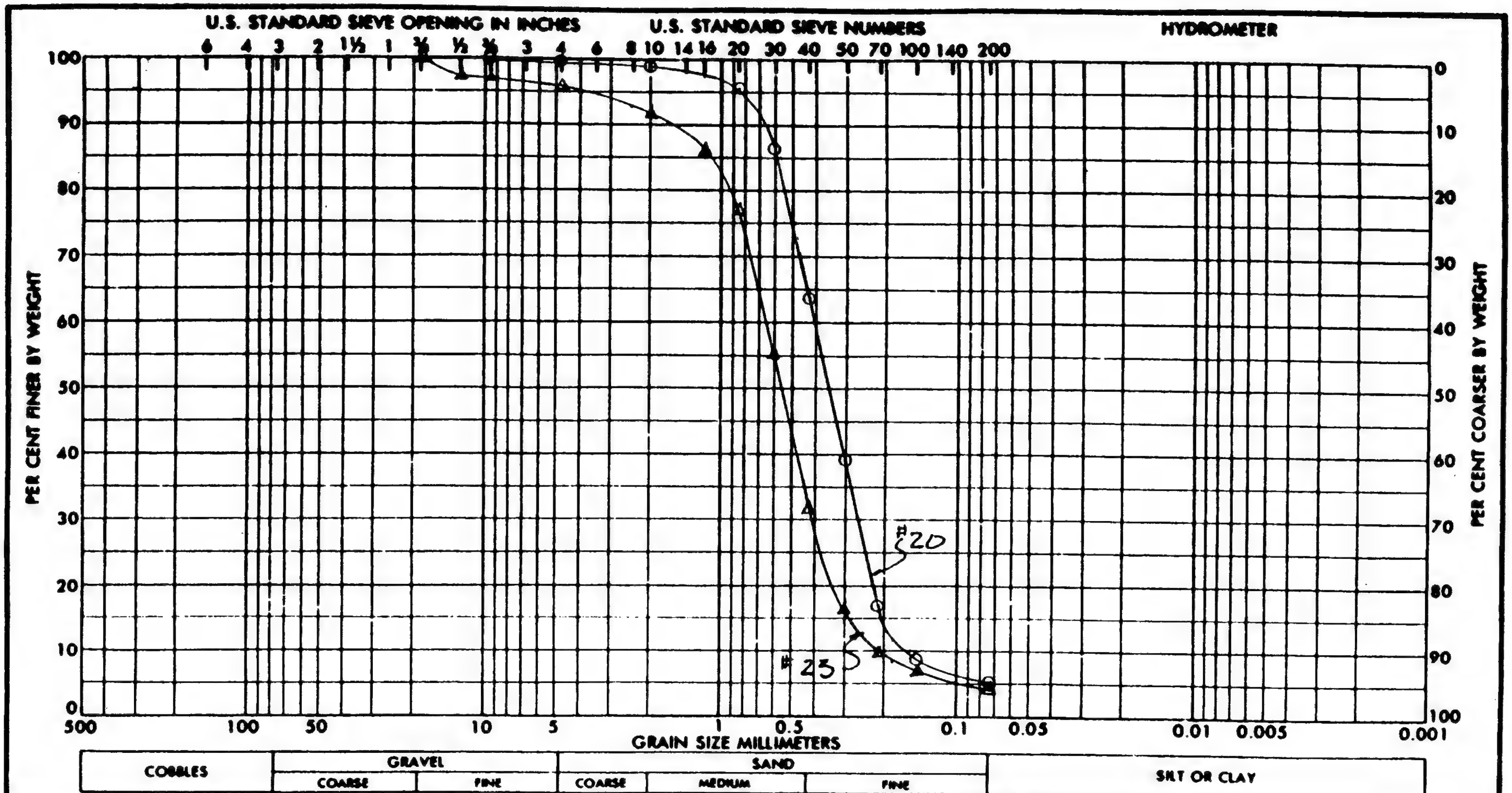
DATE MAY '73

GRADATION CURVES

U S GOVERNMENT PRINTING OFFICE 1963 OF—700-126

ENG FORM 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.
1 MAY 63

Figure C-6



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
20/3Y62	72.5'-73.5'	SAND (SP-SM.)	o	Visual		
23/3Y63	90.0'-91.0'	SAND (SP.)	Δ	ditto.		

GRADATION CURVES

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO 73-1M

DATE MAY '73

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

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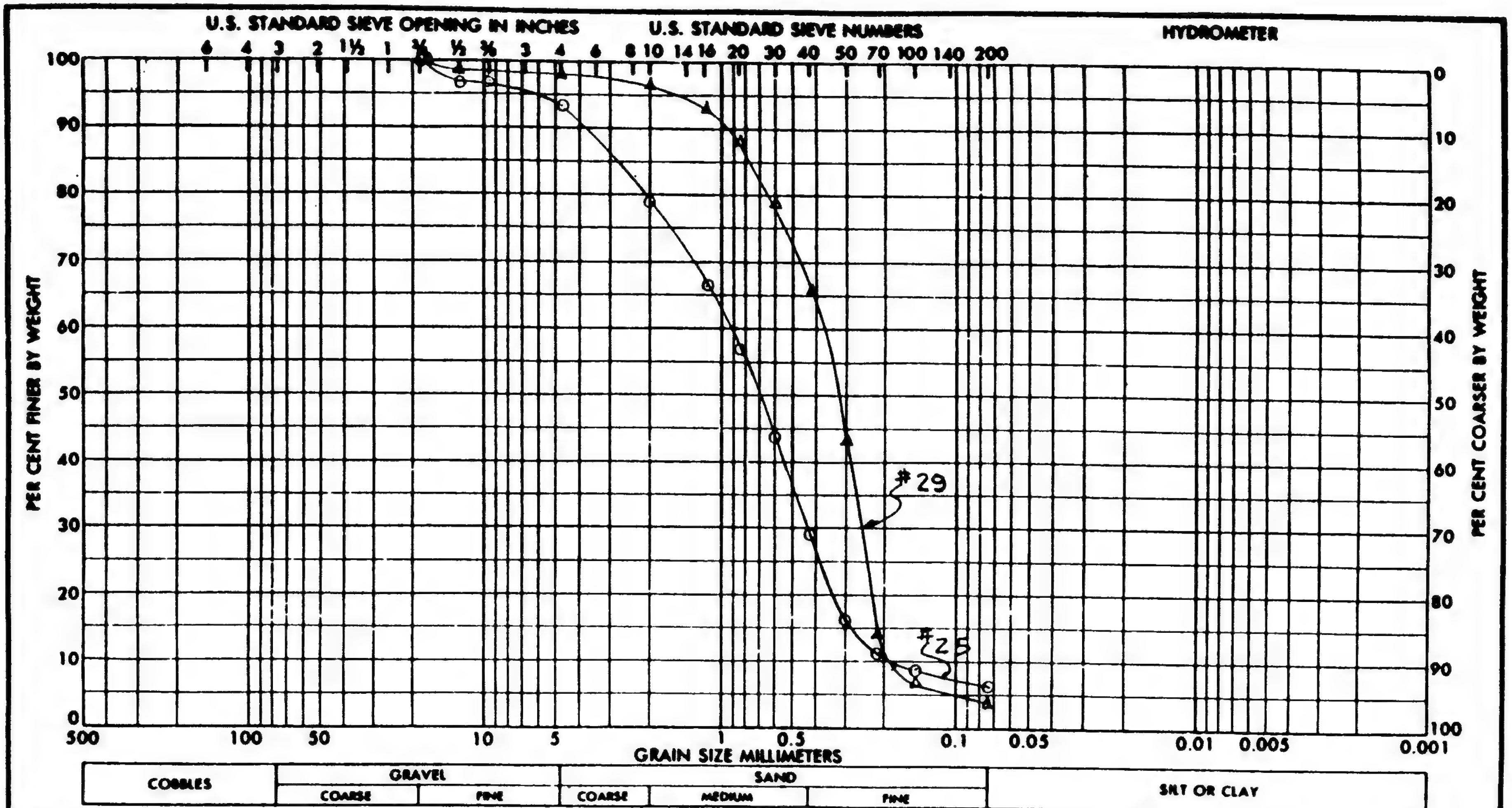
Figure C-



SAMPLE NO.	~~ELEV~~ OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
25/3Y64	100.0'-100.5'	SAND (SP-SM.)	o	Visual		
29/3Y65	120.0'-121.0'	SAND (SP.)	Δ	ditto.		

PROJECT CHASKA FLOOD CONTROL.

AREA

BORING NO 73-1M

DATE MAY '73

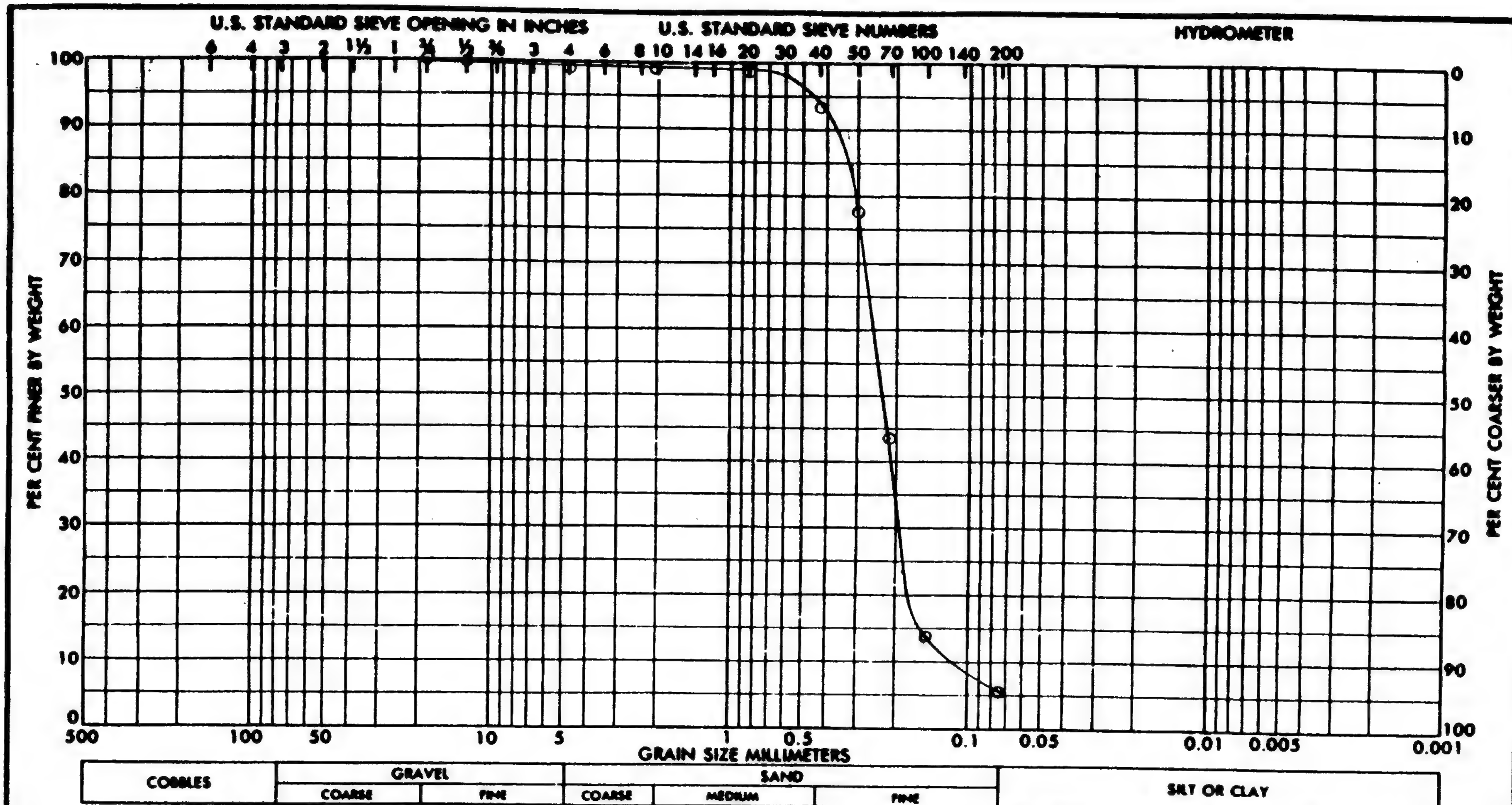
GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO 1241, SEP 1962, WHICH IS OBSOLETE

U.S. GOVERNMENT PRINTING OFFICE 1963 OF—700-126

Figure C-8



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
34/3Y 66	145.0'-146.0'	SAND (SP-SM)		VISUAL		

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO. 73-1M.

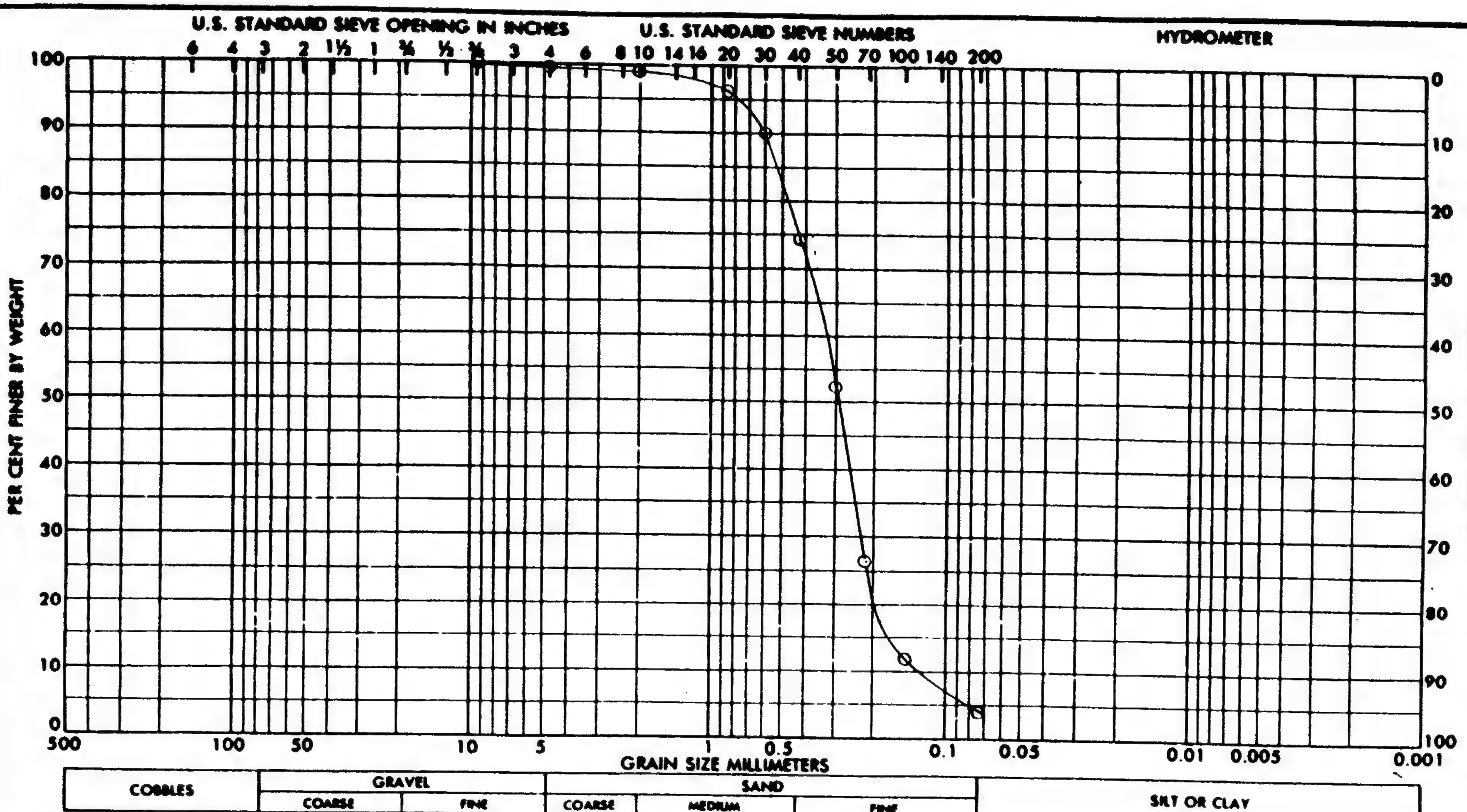
DATE MAY '73

GRADATION CURVES

ENG FORM 2087 1 MAY 63 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE 1963 O—700-120

Figure C-



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4/3Y74	7.0'-9.5'	SAND (SP)		VISUAL		

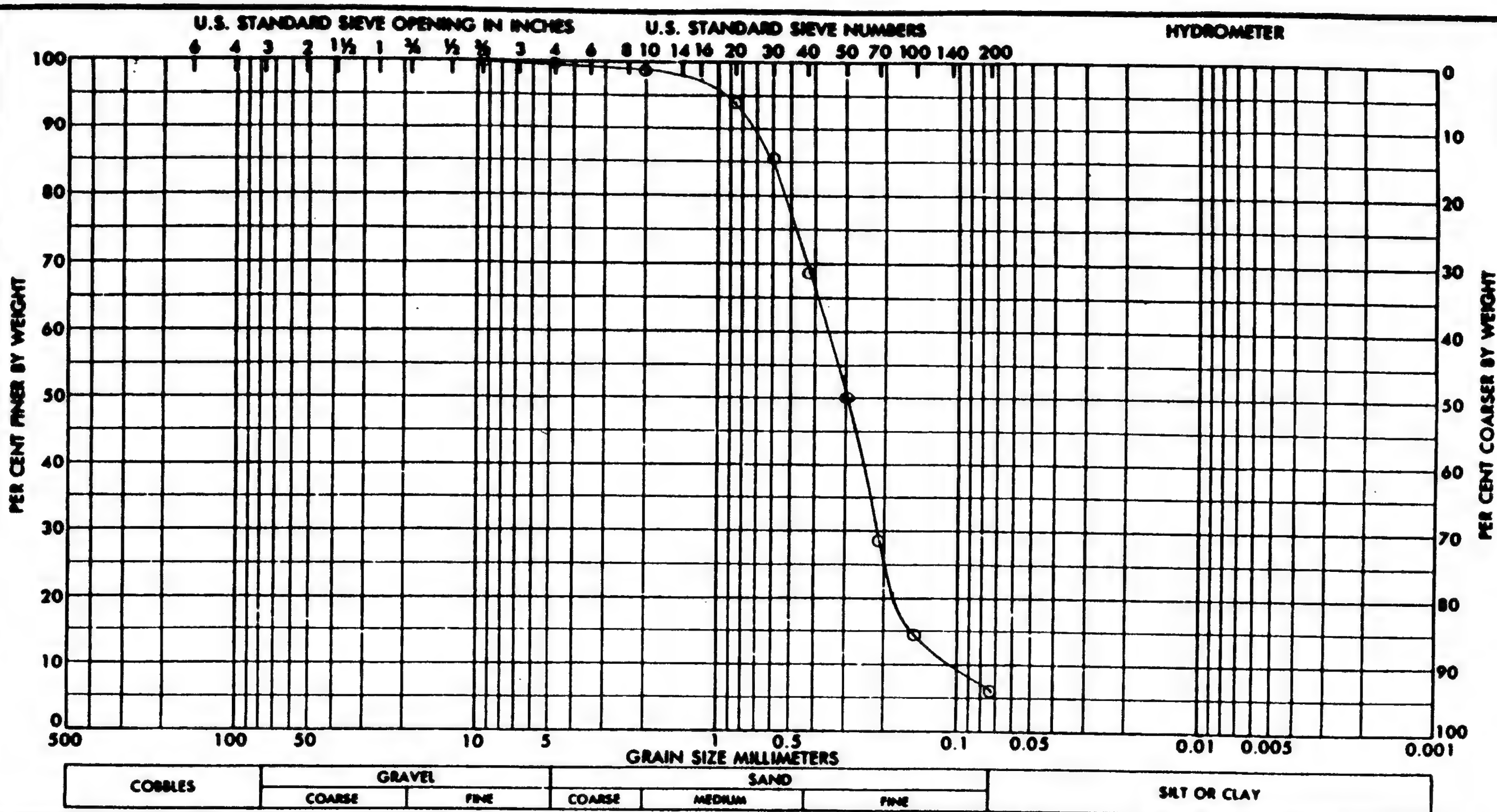
PROJECT	CHASKA FLOOD CONTROL
AREA	
BORING NO	73-5M
DATE	MAY. 73

GRADATION CURVES

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE 1963 OF—700-186

Figure C-1



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
5/3Y75	12.0'-14.5'	SAND (SP-SM.)		VisuAL		

GRADATION CURVES

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO 73-5M

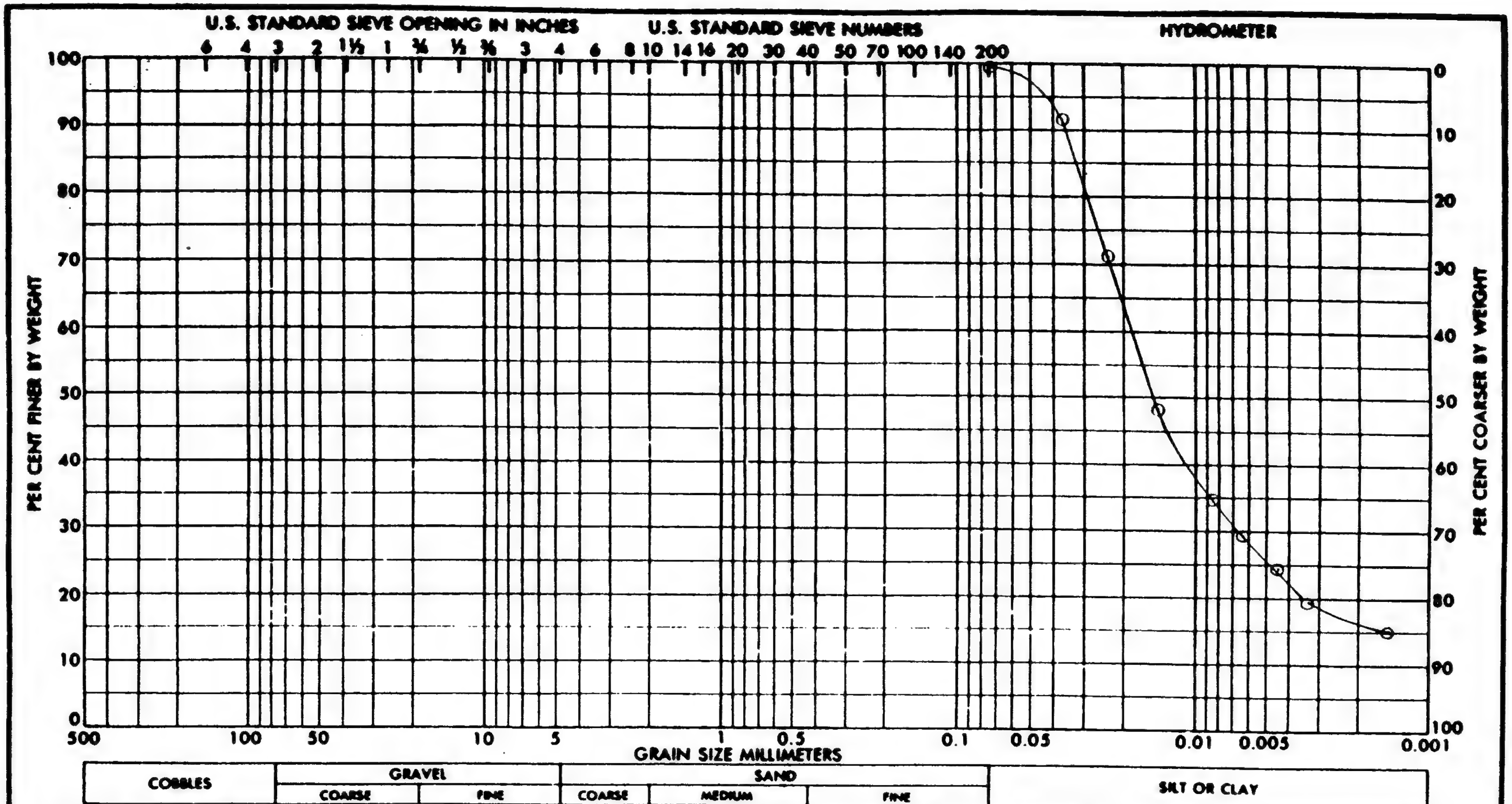
DATE MAY '73

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U S GOVERNMENT PRINTING OFFICE 1963 OF—700-188

Figure C-11



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
9/3Y 76	27.0'-29.5'	CLAY (CL)		34	19	15

PROJECT CHASKA FLOOD CONTROL.

AREA

BORING NO 73-5M

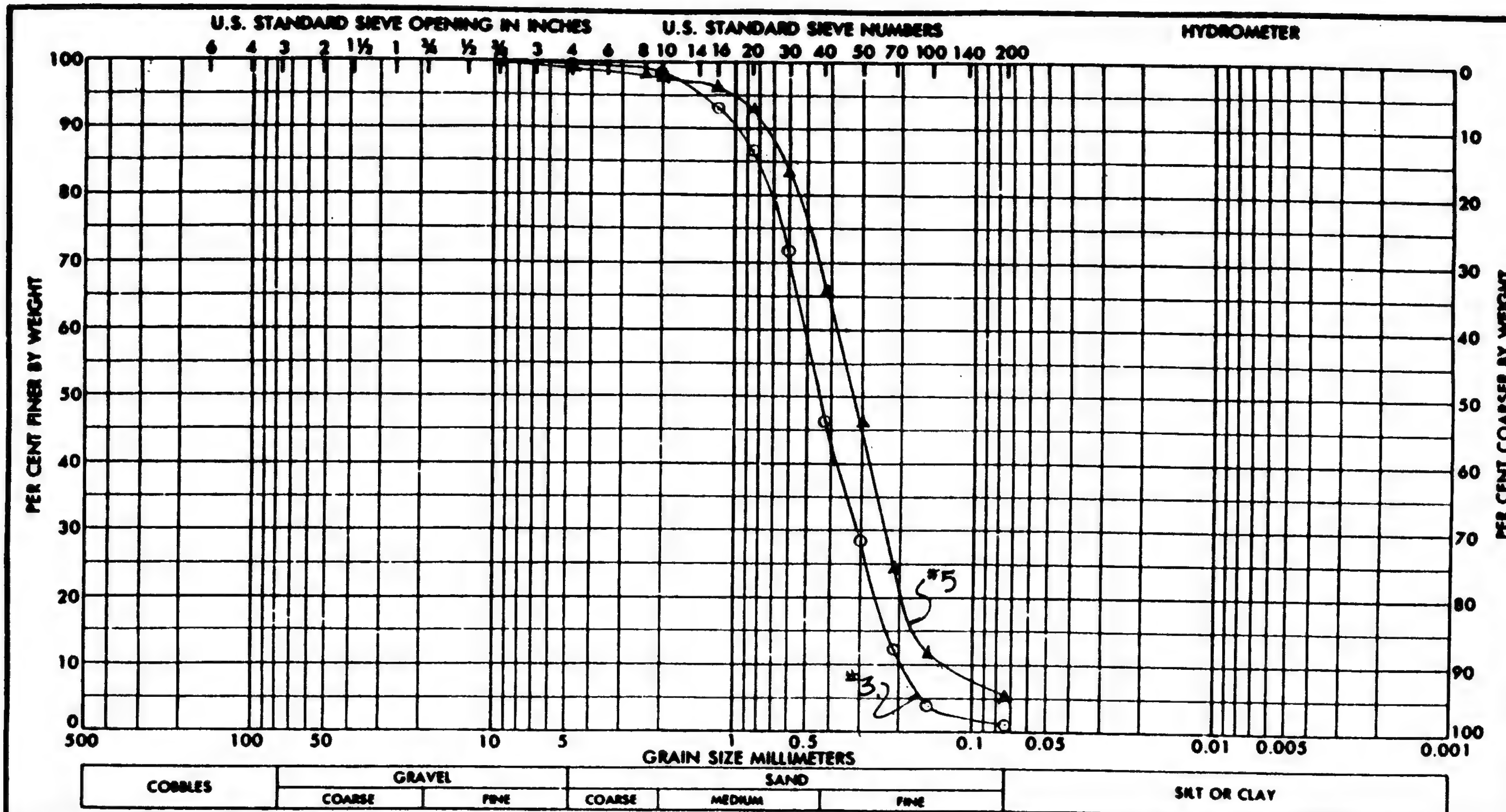
DATE MAY '73

GRADATION CURVES

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE

U S GOVERNMENT PRINTING OFFICE 1963 0F—700-126

Figure C-12



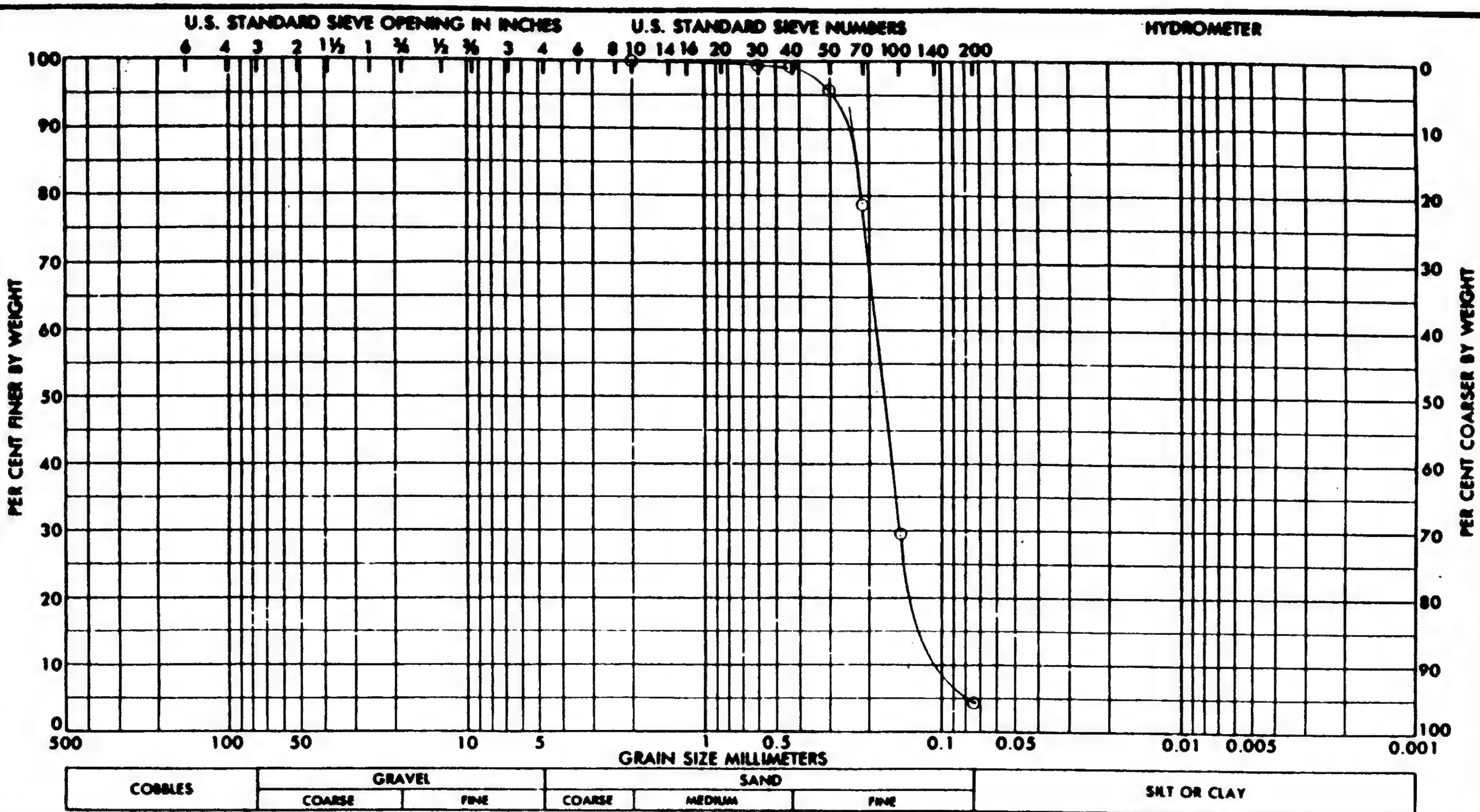
SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
3/3Y77	9.5'-12.0'	SAND (SP.)	O	VISUAL.		
5/3Y.78	19.5'-22.0'	SAND (SP-SM)	Δ	VISUAL.		

PROJECT	CHASKA FLOOD CONTROL
AREA	
BORING NO.	73-GM.
DATE	MAY '73

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
7/3Y79	27.0'-29.5'	SAND (SP)		VISUAL		

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO 73-6M.

DATE MAY. 73

GRADATION CURVES

ENG FORM 1 MAY 63 **2087** REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE

N.C.D.

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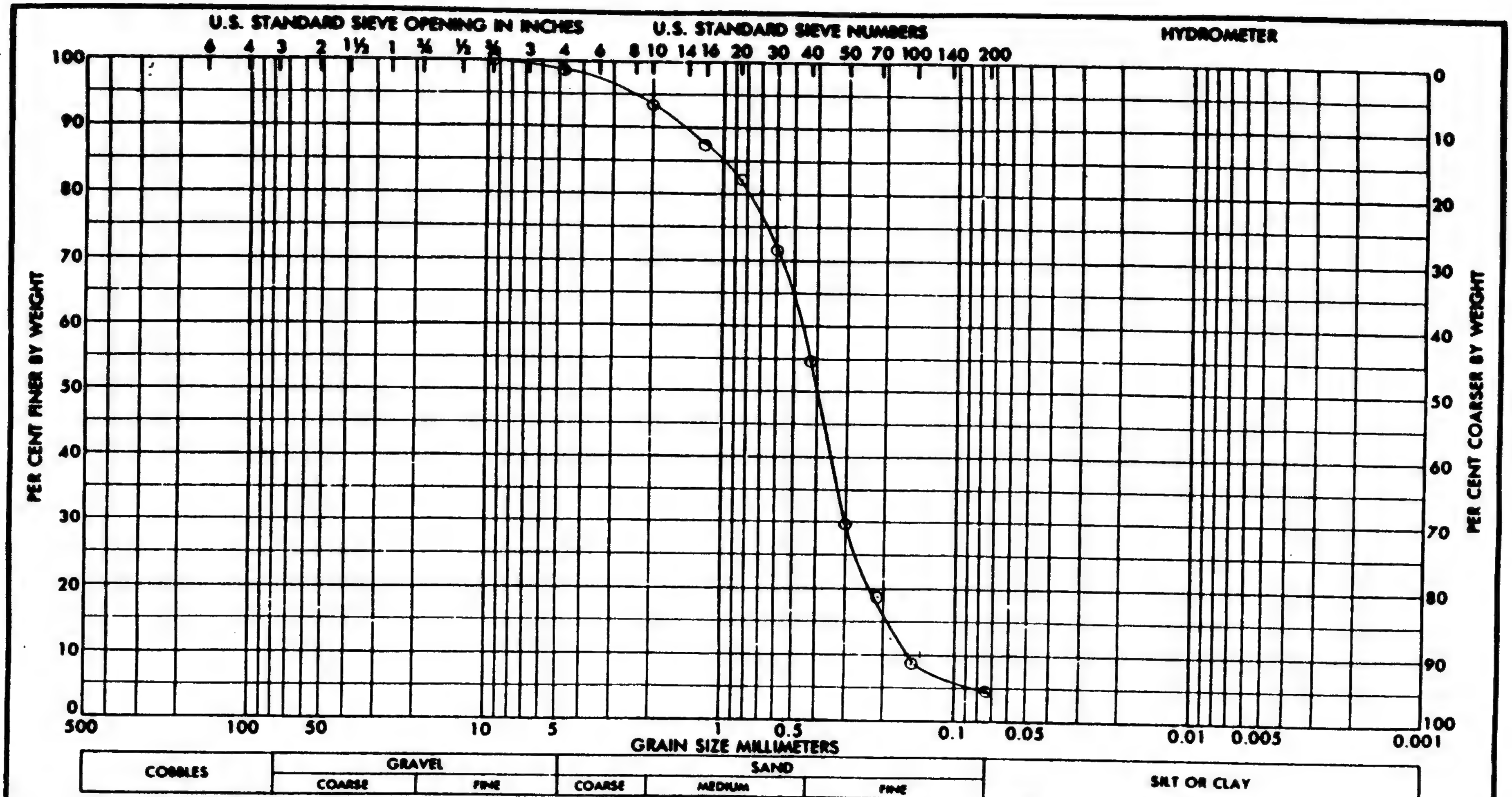
Figure C-14



SAMPLE NO.	~~ELEV~~ OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
9/3Y80	37.0'-39.5'	SAND (SP)		VISUAL		

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO. 73-6M.

DATE MAY '73

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

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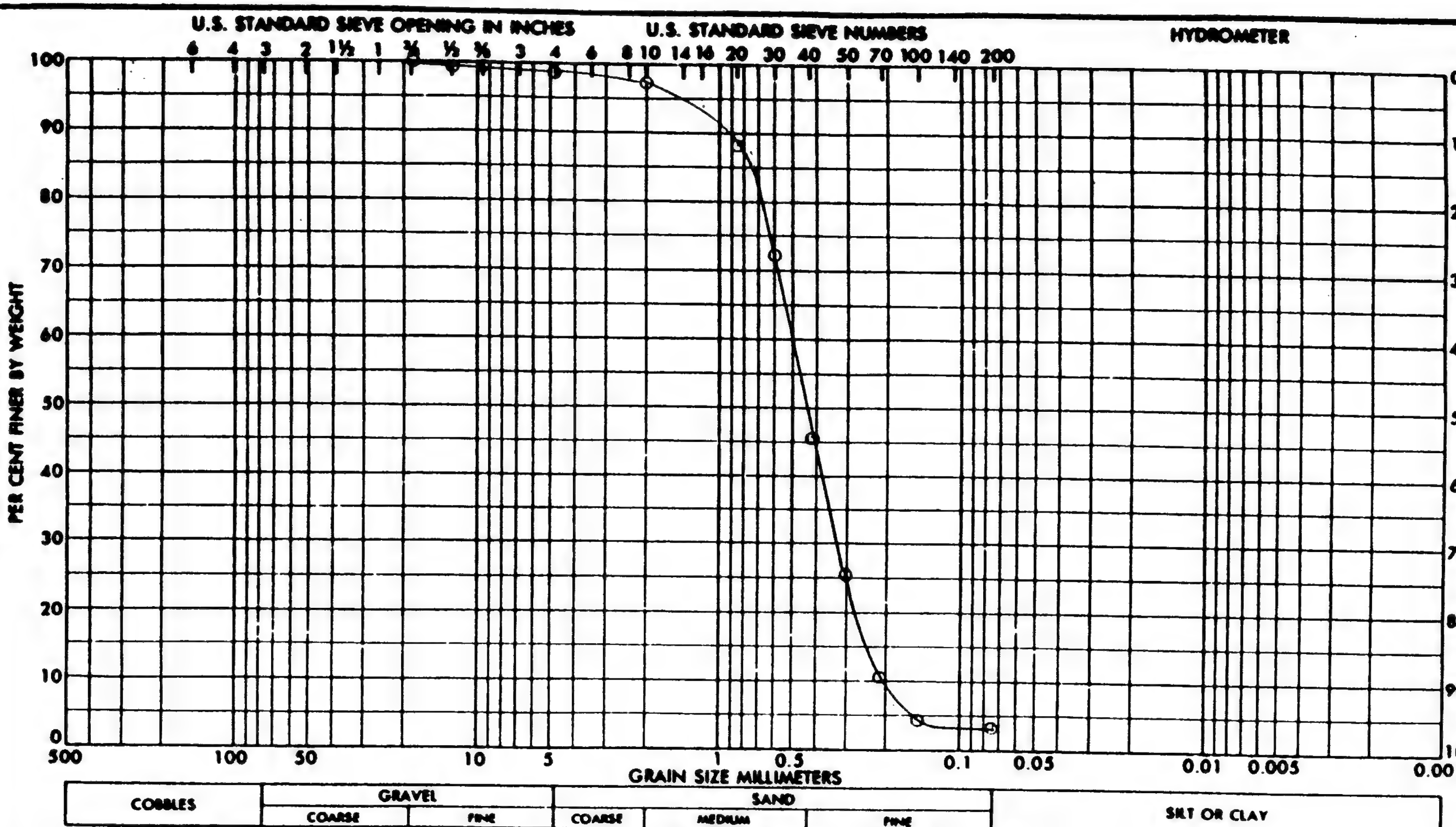
Figure C-15



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
3/3Y82	9.5'-12.0'	SAND (SP)		Visual		

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO 73-8M

DATE MAY, '78

GRADATION CURVES

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE

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Figure C-16

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska, Minnesota Flood Control	Boring No: 79-11M through 79-14M	MRD Lab. No: 79/120
Station: - / Range: - / Surf. Elev: -	Depth To Water Table: -	Bottom Of Hole: -

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	Plasticity (Att. Limits) P.I.	Grading (Cumulative Percents Finer) Hyd Anolsis Fines 005	Fines 02mm	U S Standard Sieve Sizes 200	Sand 60	Sand 40	Sand 20	Sand 10	Sand 4	Gravel 3/8	Gravel 3/4	Gravel 1 1/2	Gravel 3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech. MEMO 3-357, May 67	Remarks
Hole 79-11M																							
1	3.0						14	45	91	97	98	99	100										
3	13.0						7	26	85	98	100						0.30	0.19	0.084	3.6	1.4		
6	25.0						7	16	46	79	94	99	100				0.55	0.28	0.12	4.6	1.2		
9	38.0						4	13	80	97	98	99	100				0.31	0.23	0.15	2.1	1.1		
12	52.0						6	14	45	65	79	87	94	100			0.74	0.30	0.13	5.7	0.94		
Hole 79-12M																							
3	9.0						13	21	57	75	82	88	94	100									
6	17.0						4	9	85	97	98	99	100				0.31	0.23	0.18	1.7	0.95		
9	27.0						5	11	42	77	90	97	100				0.58	0.33	0.17	3.4	1.1		
11	34.0						13	51	93	98	100												
14	42.0						6	13	54	75	87	94	98	100			0.48	0.27	0.16	3.0	0.95		
16	54.0						7	9	26	46	62	77	87	98	100		1.8	0.45	0.18	10.0	0.63		
Hole 79-13M																							
1	1.5	21.0	26	11			18	26	36	44	51	60	76	95	100								
2	6.0						6	10	37	68	87	92	94	96	100		0.72	0.34	0.18	4.0	0.89		
4	12.8						8	22	75	97	100						0.32	0.19	0.090	3.6	1.3		
6	22.0						6	21	61	88	96	100					0.40	0.22	0.10	4.0	1.2		
10	37.0						7	15	48	78	89	94	98	100			0.53	0.34	0.12	4.4	1.8		
11	40.0	29.3	28	9																			
14	50.0						11	32	89	96	98	100					0.27	0.17	0.072	3.8	1.5		
Hole 79-14M																							
1	1.0						15	21	31	38	46	55	72	97	100								
2	6.0						8	39	87	98	100						0.25	0.14	0.080	3.1	0.98		
4	12.0						5	24	67	90	99	100					0.39	0.20	0.10	3.9	1.0		
6	22.0						6	13	43	75	90	97	99	100			0.57	0.28	0.12	4.8	1.1		
9	32.0						5	13	78	95	99	100					0.32	0.24	0.15	2.1	1.2		
14	43.0						6	13	36	55	74	89	97	100			1.1	0.35	0.14	7.9	0.80		

MRD FORM NOV. 75 16 EDITION OF MAY 70 IS OBSOLETE

Table - 1

Figure C-17

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska, Minnesota Flood Control	Boring No: 79-15M through 79-17M	MRD Lab. No: 79/120
Station: - / Range: - / Surf. Elev: -	Depth To Water Table: -	Bottom Of Hole: -

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	Plasticity (Att. Limits) P.I.	Grading (Cumulative Percents Finer) Hyd Analsis Fines 005	02mm	U S Standard Sieve Sizes 200	Sand 60	40	20	10	4	Gravel 3/8	3/4	1 1/2	3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech. MEMO 3-357, May 67	Remarks PI
Hole 79-15M																							
2	7.0	15.8	48	28																			20
3	9.5						16	21	30	36	45	58	74	95	100								
4	12.0						5	17	77	83	84	84	84	84	100		0.32	0.20	0.11	2.9	1.1		
6	22.0						14	60	97	100													
7	26.0						8	50	98	100							0.20	0.12	0.075	2.7	0.96		
9	32.0	29.8	41	21																			20
10	35.0	28.8	33	12																			21
14	46.0						7	13	39	58	77	94	100				0.94	0.31	0.15	6.3	0.68		
15	52.0	21.4	27	9																			18
17	56.0						4	15	50	74	87	94	99	100			0.52	0.27	0.13	4.0	1.0		
Hole 79-16M																							
1	2.0						22	35	56	63	67	68	69	73	100								
3	12.0						3	10	87	99	100						0.29	0.24	0.17	1.7	1.2		
5	22.0						8	60	99	100							0.17	0.11	0.078	2.2	0.91		
8	32.0						7	35	86	96	99	100					0.28	0.16	0.084	3.3	1.1		
10	40.0	25.1	38	22																			16
11	42.0	24.5	33	15																			18
12	47.0	24.0	40	24																			16
13	52.0	27.0	41	21			12	21	45	62	86	93	98	100			0.80	0.25	0.064	12.5	1.2		20
15	62.0																						
Hole 79-17M																							
1	1.0						27	37	55	69	77	82	86	89	100								
2	4.0						8	9	12	16	20	23	27	32	100		35.0	14.7	0.2	175.0	30.9		
4	11.0						8	10	14	18	25	36	48	71	100		14.0	2.8	0.15	93.3	3.7		
6	19.0						11	14	19	34	55	72	83	100			2.6	0.77	0.074	35.1	3.1		
8	26.0						8	67	98	100							0.15	0.10	0.075	2.0	0.88		
10	37.0						6	21	75	95	99	100					0.35	0.22	0.096	3.6	1.4		
14	52.0	18.7	22	7																			15
16	55.0	19.7	31	12																			19
19	67.0	18.7	43	25																			18

MRD FORM NOV. 75 16 EDITION OF MAY 70 IS OBSOLETE

Table - 2

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska, Minnesota Flood Control	Boring No: 79-18M through 79-20M	MRD Lab. No: 79/120
Station: - / Range: - / Surf. Elev: -	Depth To Water Table: -	Bottom Of Hole: -

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	P.I.	Grading (Cumulative Percents Finer) Hyd Analysis Fines .005	.02mm	U S Standard Sieve Sizes 200	Sand 80	40	20	10	4	Gravel 3/8	3/4	1 1/2	3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech. MEMO 3-357, May 67	Remarks PI
Hole 79-18M																							
2	4.0	12.7					25	42	69	75	78	84	88	94	100								
4	10.8						5	7	9	12	15	21	33	52	77	100	26.0	8.3	0.48	54.2	5.5		
7	21.9						8	17	67	82	85	87	91	93	100		0.38	0.24	0.088	4.3	1.7		
10	32.0						9	39	86	95	98	100					0.26	0.14	0.077	3.4	0.98		
13	47.0						8	14	40	68	87	96	100				0.64	0.30	0.11	5.8	1.3		
Hole 79-19M																							
2	6.0						13	21	48	66	80	89	94	98	100								
4	12.5	21.4	28	12																			16
5	14.5						21	48	80	99	100												
7	19.9						9	29	81	100							0.30	0.17	0.080	3.8	1.2		
9	25.0	25.4	30	15																			15
10	27.0	25.6	30	11																			19
13	36.0	25.7	32	12																			20
15	47.0	27.8	39	18																			21
17	57.0						5	17	52	90	100						0.44	0.25	0.12	3.7	1.2		
Hole 79-20M																							
1	2.0	21.3	36	17																			
2	5.5	16.8																					
3	6.5	17.0					8	23	79	96	100						0.35	0.20	0.080	4.4	1.4		
5	12.0	16.1					64	87	98	100													
7	19.0	17.4																					
9	25.0						26	67	94	99	100												
12	32.0	20.7	37	19																			1[illegible]
15	42.0	20.1																					
16	47.0	23.6	43	26																			17
18	55.0																						
							13	28	70	97	100												

MRD FORM NOV. 75 16 EDITION OF MAY 70 IS OBSOLETE

Table - 3

Figure C-19

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska, Minnesota Flood Control		**Boring No:** 79-21M and 79-22M	**MRD Lab. No:** 79/120
Station: -	**Range:** -	**Surf. Elev:** -	**Depth To Water Table:** -	**Bottom Of Hole:** -

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits)		Grading (Cumulative Percents Finer)												Gradation Curve Analysis					Classification	Remarks	
					Hyd Analysis		U S Standard Sieve Sizes																	
					Fines			Sand					Gravel											
			L.L.	P.I.	005	02mm	200	60	40	20	10	4	3/8	3/4	1 1/2	3 in	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Tech. MEMO 3-357, May 67		Pl
Hole 79-21M																								
2	2.0						6	12	35	60	76	85	93	100			0.81	0.35	0.14	5.8	1.1			
3	5.0	42.9	73	48																				25
4	10.0	24.5	29	15																				
6	17.0	20.9	14	0			33	90	100															14
8	22.0	19.8	39	21																				18
10	27.0	22.3	46	25																				21
Hole 79-22M																								
2	6.0	24.8	25	7																				18
4	12.0	41.9	47	28																				19
6	19.5	59.3																					Possibly organic	
7	22.0	45.2	80	53																				27
8	27.0	33.8																						
9	29.0	26.9																						
11	34.0						8	16	47	64	73	82	89	97	100		0.71	0.28	0.11	6.5	1.0			

MRD FORM NOV. 75 16 EDITION OF MAY 70 IS OBSOLETE

Table - 4

Figure C-20

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska Minnesota – Flood Control Project	Boring No: 80-23M through 80-25M	MRD Lab. No: 80/227
Station: – / Range: – / Surf. Elev: –	Depth To Water Table: –	Bottom Of Hole: –

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	P.I.	Grading (Cumulative Percents Finer) Hyd Analysis Fines 005	02mm	U S Standard Sieve Sizes 200	Sand 80	40	20	10	4	Gravel 3/8	3/4	1 1/2	3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech. MEMO 3-357, May 67	Remarks PI
Hole	80-23M																						
2	4.2						63	79	86	90	93	95	98	100									1
3	6.0	14.8	35	21			50	66	80	87	92	96	100										
4	10.8	16.4					13	24	61	83	91	96	97	100									
5	12.1	3.5																					
6	16.1	17.2	38	25			47	63	79	86	90	92	95	100									13
8	20.3	26.7																					
9	21.0	28.7																					
10	22.3	16.8					48	65	94	99	100												
11	24.3	9.7																					
12	26.5						5	27	87	99	100						0.27	0.17	0.093	2.9	1.2		
14	39.0						8	27	80	97	100						0.28	0.18	0.082	3.4	1.4		
Hole	80-24M																						
2	4.3	21.8	19	4			47	71	83	91	96	93	100										15
3	7.2	13.2																					
4	11.0	15.4					52	66	81	88	93	96	98	100									
5	16.3	14.4	31	12			48	63	85	93	97	100											1
6	17.5	21.7	45	27																			16
9	22.9	22.3	17	4																			13
Hole	80-25M																						
5	6.9	10.[illegible]					40	58	76	85	92	97	99	100									
6	13.4						6	10	25	46	79	100					1.2	0.48	0.16	7.5	1.2		
9	21.5						31	59	75	81	86	92	95	100									
10	24.2	15.[illegible]					39	75	87	90	91	92	94	94	100								
12	31.7						No sample received																
13	39.6						No sample received																
14	41.9						No sample received																
15	49.3	44.4																					
16	51.1	23.3	38	25																			13

MRD FORM NOV. 75 16 EDITION OF MAY 70 IS OBSOLETE

Table – 1

Figure C-21

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska Minnesota - Flood Control Project

Boring No: 80-26M through 80-28M

MRD Lab. No: 80/227

Station: -

Range: -

Surf. Elev: -

Depth To Water Table: -

Bottom Of Hole: -

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	Plasticity (Att. Limits) P.I.	Grading (Cumulative Percents Finer) Hyd Anlysis Fines 005	02mm	U S Standard Sieve Sizes 200	Sand 80	40	20	10	4	Gravel 3/8	3/4	1 1/2	3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech. MEMO 3-357, May 67	Remarks PI.
Hole	80-26M																						
2	3.6						30	37	44	47	50	54	59	65	85	100							
3	6.0						64	69	75	78	81	86	87	98	100								
4	14.2	17.7	52	37			93	96	98	99	100												15
5	15.9	21.3																					
7	21.6	26.9					45	85	99	99	100												
8	26.3	39.4																					
9	27.3	30.4																					
11	28.9	27.9																					
13	31.1						No	sample recieved															
14	41.3	24.6	21	4																			17
Hole	80-27M																						
1	4.0	14.3																					
2	8.0	21.7	39	23																			16
3	13.0						6	7	8	10	11	13	16	27	64	100	33.0	19.0	1.2	27.5	0.91		
6	25.0	22.3	20	4																			16
7	28.0	20.3																					
Hole	80-28M																						
2	6.1						7	11	25	43	60	77	89	98	100		2.0	0.47	0.17	11.8	0.65		
3	9.2	19.1					5	15	60	85	93	100					0.42	0.25	0.12	3.5	1.2		
5	11.9	41.7	43	22																			21
6	14.2	30.5	41	21																			20
8	19.2						49	63	76	85	91	96	99	100									
9	21.5	28.0																					
10	27.4	23.9					35	49	75	85	90	96	100										

Table - 2

MRD FORM NOV. 75 16 EDITION OF MAY 70 IS OBSOLETE

Figure C-22

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska Flood Control	Boring No: 82-39M through 82-42M	MRD Lab. No: 83/67
Station: – Range: – Surf. Elev: –	Depth To Water Table: –	Bottom Of Hole: –

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	P.I.	Grading (Cumulative Percents Finer) Hyd Analysis Fines .005	.02mm	U S Standard Sieve Sizes 200	Sand 80	40	20	10	4	Gravel 3/8	3/4	1 1/2	3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech. MEMO 3-357, May 67	Remarks	PL
Hole	82-39M																							
2	6.5	25.4					26	79	99	100														
3	11.5	53.3					62	93	99	100														
4	14.5	18.9					8	16	47	79	96	99	100				0.53	0.25	0.087	6.1	1.4			
6	21.5						2	4	9	16	39	82	100				3.6	1.5	0.50	7.2	1.3			
7	26.5						13	26	57	76	89	95	100											
Hole	82-40M																							
2	6.2	34.0	35	15			83	94	98	100												Loss on Ignition 3.4%		20
3	11.0	29.2					13	35	74	92	99	100												
4	16.5						6	10	21	31	39	51	60	71	100		9.7	0.78	0.18	53.9	0.35			
6	26.5	21.0					89	100																
7	31.5	22.5	34	18																				16
8	36.5	24.3	49	29																				20
Hole	82-41M																							
1	1.5	35.9	36	19																				17
2	6.5																					Loss on Ignition 8.3%		
3	11.5																					Loss on Ignition 6.6%		
4	16.5	50.3	70	47																		Loss on Ignition 5.5%		23
7	27.0	25.2	24	4																				20
8	31.5	25.5	42	23																				19
Hole	82-42M																							
1	1.5	34.8	48	27																		Loss on Ignition 4.9%		21
2	6.5	106.6	122	69																		Loss on Ignition 18.2%	Peat	53
3	11.5																					Loss on Ignition 13.8%		
4	16.5	298.6	335	163																		Loss on Ignition 43.2%	Peat	172
6	26.4																					Peat, Limestone, Sand mix		
7	29.5	32.1	31	14																				17
8	31.5	69.6	92	51																		Loss on Ignition 12.9%		41
9	34.5	40.3	42	21																				21
10	36.5	32.6	36	19																				17
11	39.5	72.1	NP	NP																		Shells, limestone, sand mix		

MRD FORM NOV. 75 16 EDITION OF MAY 70 IS OBSOLETE

Table - 1

Figure C-23

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska Flood Control		Boring No: 82-47M, 82-48M, 82-50M and 82-51M	MRD Lab. No: 83/67
Station: -	Range: -	Surf. Elev: -	Depth To Water Table: -
			Bottom Of Hole: -

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	Plasticity (Att. Limits) P.I.	Grading (Cumulative Percents Finer) Hyd Analysis Fines 005	Fines 02mm	U S Standard Sieve Sizes 200	Sand 80	Sand 40	Sand 20	Sand 10	Sand 4	Gravel 3/8	Gravel 3/4	Gravel 1 1/2	Gravel 3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech. MEMO 3-357, May 67	Remarks PL
Hole	82-47M																						
2	6.5	21.6					92	100															
6	21.5	21.6	NP	NP																			
9	36.5	20.7					17	89	100														
Hole	82-48M																						
1	1.5	57.9	92	48																			44
3	9.5	19.7	NP	NP			12	24	73	88	95	100					0.36	0.20	0.050	7.2	2.2		
4	11.5	36.4	43	23																			20
5	12.0	22.9	26	11			64	88	99	100													15
7	21.5	21.5	33	18																			15
9	31.5						29	95	100														
Hole	82-50M																						
2	6.5	22.1					4	9	66	89	93	95	96	96	100		0.40	0.28	0.17	2.4	1.2		
4	11.5																					Loss on Ignition 3.7%	
5	21.5	23.8	39	20																			19
7	26.5	23.3	20	14																			16
Hole	82-51M																						
1	1.5																					Fill - No test	
2	6.5	13.8					32	44	59	68	78	90	98	100									
4	16.5	21.3																				Fill - No test	
5	21.5																						Glass and peat
8	36.5	55.9	89	54																			35
10	44.5	4.2	NP	NP			10	13	21	28	39	52	73	93	100		6.0	0.98	0.074	81.1	2.2		Gravel

MRD FORM NOV. 75 16 EDITION OF MAY 70 IS OBSOLETE

Table - 3

Figure C-24

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska Flood Control		Boring No: 83-52M through 83-57M	MRD Lab. No: 84/34
Station:	Range:	Surf. Elev:	Depth To Water Table:	Bottom Of Hole:

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	P.I.	Grading (Cumulative Percents Finer) Hyd Analysis Fines .005	.02mm	U S Standard Sieve Sizes 200	Sand 80	40	20	10	4	Gravel 3/8	3/4	1 1/2	3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech MEMO 3-357, May 67	Remarks PL
Hole 83-52M																							
3	8.6						7	9	15	48	88	100					0.98	0.58	0.19	5.2	1.8		
7	16.5						5	30	92	100							0.28	0.18	0.088	3.2	1.3		
12	36.5	23.4	35	15																			20
13	41.5	21.7	NP	NP			47	96	100														
Hole 83-53M																							
2	3.5	35.4	45	24																			21
4	9.5	32.3	39	22																			17
6	14.5	32.5	35	13																			22
11	29.5	91.6	210	171																			Organic 39
Hole 83-54M																							
1	1.5	7.5	31	13																			18
3	11.5						18	69	99	100													
5	15.5						7	21	71	99	98	100					0.35	0.22	0.090	3.9	1.5		
Hole 83-55M																							
1	2.0						38	52	68	77	84	90	93	97	100								
2	4.5						43	84	90	93	95	97	100										
5	14.5						18	25	44	60	70	78	86	92	100								
7	22.8						4	9	33	52	62	73	83	88	100		1.5	0.42	0.18	8.3	0.65		
Hole 83-56M																							
2	7.5	29.0	34	16																			18
3	12.5						3	6	13	21	31	49	77	88	100		6.4	1.8	0.30	2.13	1.8		
4	14.5						5	14	58	82	95	100					0.43	0.24	0.14	3.1	0.96		
Hole 83-57M																							
4	14.5						5	7	14	21	30	42	54	64	100		14.0	1.9	0.27	51.[illegible]	0.96		
5	19.0						6	9	20	30	43	60	73	83	100		5.0	0.90	0.19	[illegible].3	0.85		

Table - 1

MRD FORM NOV. 75 16 EDITION OF MAY 70 IS OBSOLETE

Figure C-25

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska Flood Control	Boring No: 83-58M through 83-63M	MRD Lab. No: 84/34
Station: / Range: / Surf. Elev:	Depth To Water Table:	Bottom Of Hole:

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	Plasticity (Att. Limits) P.I.	Grading (Cumulative Percents Finer) Hyd Analysis Fines .005	.02mm	U S Standard Sieve Sizes 200	Sand 80	40	20	10	4	Gravel 3/8	3/4	1 1/2	3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech. MEMO 3-357, May 67	Remarks	PL
Hole 83-58M																								
2	6.5	25.9	32	16																				16
4	12.5	31.7	38	21																				17
6	19.5	28.8	27	8																				19
9	27.5	78.1	125	79																			Organic	46
Hole 83-59M																								
2	4.5						33	67	84	87	90	92	94	100										
4	14.5	13.1	30	17																				13
5	20.0						6	24	66	93	98	99	100				0.35	0.20	0.089	3.9	1.3			
8	34.5						10	23	75	90	97	100					0.31	0.25	0.077	4.0	2.6			
Hole 83-60M																								
1	2.0						79	92	97	98	100													
4	14.5	17.7	32	17			55	70	84	90	95	98	100											15
7	24.5						8	19	76	95	97	98	100				0.34	0.24	0.089	4.0	2.0			
Hole 83-61M																								
2	4.5						8	11	19	26	34	51	68	86	100		6.8	1.2	0.16	42.5	1.3			
6	24.5	26.1	25	6																				19
Hole 83-62M																								
2	6.5	47.5	76	54																			Organic	22
4	11.5	30.0	22	3			55	90	100															19
5	14.5						32	71	100															
6	15.8						19	29	41	46	53	64	75	88	100									
9	26.5	21.4	23	4																				19
Hole 83-63M																								
3	11.5	92.0	120	76													Loss on Ignition			12.0%			Organic	44
4	14.5	188.3	216	119													Loss on Ignition			37.2%			Organic	97
5	16.5	52.5	83	61													Loss on Ignition			6.8%			Organic	22
6	24.5						15	44	94	96	97	98	99	100										

MRD FORM 16 NOV. 75 EDITION OF MAY 70 IS OBSOLETE

Table - 2

Figure C-26

SOIL CLASSIFICATION RECORD SHEET

PROJECT: Chaska Flood Control - East Creek | BORING: 88-100M through 88-103M | MRD LAB NO. 88/177

STATION: | RANGE: | SURF.ELEV.: | DEPTH TO WATER TABLE: | BOTTOM OF HOLE:

			PLASTICITY (ATT. LIMITS)		GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES		U.S. STANDARD SIEVE SIZE SANDS						GRAVEL				GRADATION CURVE ANALYSIS					CLASSIFICATION		
SAMP NO.	DEPTH TO BOTTOM OF SAMP	MOIST-URE (%)	LL	PI	.005	.02mm	200	80	40	20	10	4	3/8	3/4	1-1/2	3 IN	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	88-100M																							
1	0.3						Loss	on	Ignit	ion	23.5	%												
2	3.0	121.5	106	45																				61
4	15.0						Lost	in	test.															
5	16.9						54	93	100															
Hole	88-101M																							
1	0.8	12.0	42	23																				19
10	29.1	36.1	41	23																				18
12	33.9	22.7	26	6																				20
Hole	88-102M																							
4	11.6	29.0	22	2																				20
8	32.6	24.3	24	5																				19
Hole	88-103M																							
6	25.4						10	13	21	32	40	50	69	85	100		6.80	0.72	0.05	128.30	1.44			
8	33.9	26.3	31	17																				14
10	41.4	27.3	23	3																				20
12	51.2	27.9	39	23																				

Note: Sample jars contained standing water. This has resulted in the moisture content of some samples being higher than the liquid limit.

TABLE 1

SOIL CLASSIFICATION RECORD SHEET

PROJECT: Chaska Flood Control Project - Minnesota River Levee (Stage 4) | BORING: 89-106a, 89-110m, 89-111a, and 89-113a | MRD LAB NO. 90/135

STATION: | RANGE: | SURF. ELEV.: | DEPTH TO WATER TABLE: | BOTTOM OF HOLE:

SAMP NO.	DEPTH TO BOTTOM OF SAMP.	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PLASTICITY (ATT. LIMITS) PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE 200	SANDS 80	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	89-106																							
1	4.0						29	40	58	69	77	81	94	100										
2	9.0						23	52	71	78	83	87	91	96	100									
4	19.0						13	22	48	63	75	84	95	100										
5	24.0						6	18	71	87	95	98	99	100			0.29	0.13	0.08	3.87	1.49			
9	39.0	70.9	86	56																				30
Hole	89-110																							
1	1.8						34	54	65	71	75	76	84	94	100									
2	5.0	15.5	22	4																				18
3	7.0	9.4	22	10																				12
4	9.7	9.3	18	2																				16
5	10.6	11.6	28	12																				16
6	16.3						26	56	72	79	85	90	94	100										
Hole	89-111																							
1	1.9						12	18	33	49	64	74	81	89	100		1.60	0.35	0.06	26.67	1.28			
2	3.7						11	15	25	35	46	58	73	88	100		5.00	0.60	0.07	71.43	1.03			
5	20.2						26	41	53	62	71	79	82	85	100									
6	24.5						13	22	35	49	65	77	86	93	100									
7	30.0	29.6	51	25																				26
9	37.4	41.1	69	42																				27
Hole	89-113																							
3	14.0						13	19	53	93	98	99	100											
6	25.0						3	11	61	88	96	99	99	100			0.40	0.26	0.16	2.50	1.06			
7	29.5						4	13	58	87	97	99	99	100			0.43	0.20	0.12	3.58	0.78			
9	35.0						24	87	100															
10	40.0						7	15	55	90	99	100					0.45	0.26	0.12	3.75	1.25			
11	44.0						8	16	68	93	97	99	100				0.38	0.23	0.12	3.17	1.16			
13	54.0						6	11	35	54	72	86	96	100			1.10	0.35	0.16	6.88	0.70			
16	67.0						7	22	84	93	97	100					0.24	0.19	0.10	2.42	1.52			
17	72.6						7	12	39	60	74	86	96	100			0.57	0.32	0.15	3.93	1.24			

TABLE 1

Figure C-28

SOIL CLASSIFICATION RECORD SHEET

PROJECT: Chaska Flood Control Project - Minnesota River Levee (stage 4) | BORING: 89-114m through 89-116m | MRD LAB NO. 90/135

STATION: | RANGE: | SURF.ELEV.: | DEPTH TO WATER TABLE: | BOTTOM OF HOLE:

SAMP NO.	DEPTH TO BOTTOM OF SAMP	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE SANDS 200	60	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	89-114																							
2	5.8						3	14	65	92	98	99	100				0.35	0.23	0.13	2.80	1.21			
4	19.5						7	42	86	94	97	99	100				0.23	0.12	0.07	3.29	0.89			
5	24.5						5	15	53	76	91	97	99	100			0.50	0.24	0.12	4.17	0.96			
6	29.0						6	21	90	99	100						0.29	0.20	0.10	2.75	1.44			
7	34.0						7	15	56	88	97	99	100				0.45	0.24	0.11	4.09	1.16			
8	39.9						10	28	97	99	100						0.24	0.14	0.08	3.00	1.05			
9	44.0						8	14	41	61	76	87	96	100			0.80	0.29	0.11	7.27	0.96			
11	54.5						7	11	34	59	78	87	97	100			0.89	0.35	0.16	5.56	0.86			
14	65.7						6	26	80	90	96	99	100				0.25	0.18	0.09	2.78	1.44			
15	69.5						11	16	38	60	77	88	97	100			0.82	0.30	0.04	20.50	2.74			
16	73.3						10	14	26	43	64	80	92				1.80	0.46	0.09	20.00	1.31			
Hole	89-115																							
1	3.7						19	27	56	74	81	85	91	100										
3	11.5						6	23	69	96	99	100					0.37	0.20	0.09	4.11	1.20			
4	17.5						8	22	70	88	96	98	100				0.35	0.20	0.09	3.89	1.27			
5	19.0						7	13	96	83	96	99	100				0.50	0.27	0.09	5.88	1.72			
6	24.1	19.2	25	7																				18
7	29.0						6	35	94	99	100						0.24	0.16	0.09	2.32	1.25			
8	34.0						7	13	40	75	90	96	99	100			0.60	0.36	0.13	4.62	1.66			
9	39.0						4	29	96	100							0.25	0.17	0.09	2.78	1.31			
12	54.0						8	12	31	52	73	84	96	100			1.10	0.39	0.12	9.17	1.15			
15	59.5						6	10	29	58	73	83	95	100			0.90	0.43	0.16	5.63	1.28			
Hole	89-116																							
1	3.5						24	61	98	99	100													
2	10.0						13	20	33	41	54	67	80	90	100									
3	15.0						22	30	57	78	89	96	100											
5	22.0						4	13	67	89	95	97	99	100			0.35	0.23	0.15	2.33	1.01			
7	34.5						7	15	60	87	96	98	100				0.40	0.25	0.10	4.00	1.56			
8	40.0						9	49	98	99	100						0.20	0.12	0.08	2.56	0.92			
9	44.0						7	11	30	79	94	98	100				0.52	0.40	0.16	3.25	1.92			
11	48.6						5	10	86	94	97	99	100				0.28	0.24	0.18	1.56	1.14			
12	50.0	18.5	17	2																				15
14	55.0						9	17	50	73	85	93	100				0.51	0.24	0.09	6.00	1.33			
16	62.2						19	68	92	98	100													
17	64.5						8	14	42	69	84	93	98	100			0.53	0.32	0.12	4.42	1.61			
18	70.0						15	41	91	97	99	99	100											

TABLE 2

Figure C-29

SOIL CLASSIFICATION RECORD SHEET

PROJECT: Chaska Flood Control Project - Minnesota River Levee (Stage 4)

BORING: 89-117a

MRD LAB NO. 90/135

STATION: | RANGE: | SURF.ELEV.: | DEPTH TO WATER TABLE: | BOTTOM OF HOLE:

SAMP NO.	DEPTH TO BOTTOM OF SAMP	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE SANDS 200	80	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	89-117																							
1	0.7	20.8	34	11																				
2	1.4	*	81	28																				23
3	4.0						9	11	22	31	45	56	75	84	100		5.0	0.78	0.13	38.46	0.94		Organic	53
6	19.0	15.9																						
9	24.0	25.3	24	4																			Slight plasticity	20

* Lost in test.

TABLE 3

SOIL CLASSIFICATION RECORD SHEET

PROJECT: Chaska Flood Control Project - Minnesota River Levee | BORING: 89-118m through 89-119m | MRD LAB NO. 90/135

STATION: | RANGE: | SURF. ELEV.: | DEPTH TO WATER TABLE: | BOTTOM OF HOLE:

SAMP NO.	DEPTH TO BOTTOM OF SAMP	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE 200	SANDS 30	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	89-118																							
1	1.6	9.2	21	8																				13
2	4.0	8.8	21	4																				17
3	9.5						47	63	80	89	94	97	100											
4	14.5						52	70	84	89	93	96	100											
5	18.6						47	71	93	99	100													
6	19.4						44	75	96	98	100													
7	24.5						6	12	51	82	95	99	100				0.46	0.33	0.15	3.07	1.58			
8	29.0						10	38	81	92	97	100					0.22	0.16	0.07	3.14	1.66			
10	39.5						4	10	40	73	90	96	99	100			0.60	0.33	0.18	3.33	1.01			
11	44.0						11	57	95	99	100						0.18	0.11	0.07	2.57	0.96			
13	54.0						7	13	51	80	93	98	100				0.43	0.33	0.13	3.31	1.95			
15	62.2	19.4	20	3																				17
17	74.0						7	12	33	57	72	84	95	100			0.92	0.34	0.15	6.13	0.84			
19	84.0						12	26	77	92	98	99	100				0.29	0.19	0.07	4.14	1.78			
21	94.0						8	15	44	71	84	73	99	100			0.57	0.33	0.10	5.70	1.91			
22	97.0						8	13	24	40	56	73	91	100			2.50	0.55	0.12	20.83	1.01			
24	104.5						5	12	30	60	78	89	96	100			0.85	0.40	0.14	6.07	1.34			
26	114.0						10	15	31	46	58	70	85	95	100		2.10	0.41	0.06	35.00	1.33			
28	121.9						5	10	68	91	98	100					0.40	0.29	0.17	2.35	1.24			
29	123.8						12	22	67	90	97	99	100				0.40	0.23	0.05	8.00	2.65			
30	126.9						9	21	51	84	94	96	99	100			0.43	0.26	0.08	5.38	1.97			
31	128.0	22.0	23	1																				22
32	130.0						12	21	59	82	93	97	100				0.43	0.26	0.05	8.60	3.14			
33	134.5						8	19	91	98	100						0.28	0.23	0.09	3.11	2.10			
34	139.5						6	12	40	75	91	97	100				0.49	0.34	0.15	3.27	1.57			
35	144.5						7	14	42	86	97	98	100				0.46	0.33	0.13	3.54	1.82			
36	149.0						12	25	75	90	96	98	100				0.31	0.20	0.06	5.17	2.15			
37	149.9						22	49	100															
38	151.5	22.9	31	15																				16
39	152.0						18	39	74	94	98	100												
Hole	89-119																							
10	44.0	24.0	37	21																				16

TABLE 1

Figure C-31

SOIL CLASSIFICATION RECORD SHEET

PROJECT: Chaska Flood Control Project - Minnesota River Levee | BORING: 89-121m through 89-123m | MRD LAB NO. 90/135

STATION. | RANGE: | SURF. ELEV.: | DEPTH TO WATER TABLE: | BOTTOM OF HOLE:

SAMP NO.	DEPTH TO BOTTOM OF SAMP.	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE SANDS 200	80	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	89-121																							
1	4.0	24.0	[illegible]	31																				25
2	6.5						6	15	73	93	99	100					0.41	0.27	0.10	4.10	1.78			
3	11.0						2	14	89	93	100						0.23	0.20	0.15	1.53	1.16			
4	19.0	24.7	29	11																				18
6	29.5	26.9	34	15																				19
8	39.0						7	19	75	92	98	100					0.31	0.23	0.10	3.10	1.71			
9	43.5	22.9	33	14																				19
11	46.2	24.9	31	15																				16
Hole	89-122																							
1	1.2						16	25	39	48	57	67	77	80	80	100								
2	5.0						3	11	55	87	95	98	100				0.43	0.23	0.17	2.53	1.07			
3	10.0						4	21	95	99	100						0.19	0.18	0.12	1.56	1.42			
4	12.0						8	13	33	62	81	93	97	100			0.80	0.37	0.13	6.15	1.32			
5	14.5						5	12	67	92	99	100					0.40	0.30	0.14	2.86	1.61			
6	17.8						9	43	95	99	100						0.18	0.14	0.08	2.25	1.36			
7	24.5						6	22	79	94	98	100					0.33	0.22	0.09	3.67	1.63			
8	30.0						9	53	96	100							0.17	0.16	0.08	2.13	1.88			
10	39.5						6	12	56	81	95	99	100				0.44	0.35	0.15	2.93	1.86			
11	44.5						5	9	31	60	84	96	99	100			0.85	0.40	0.18	4.72	1.05			
13	51.3						4	14	82	93	97	100					0.27	0.24	0.15	1.80	1.42			
15	60.0						9	13	30	49	71	86	93	100			1.30	0.42	0.11	11.82	1.23			
18	74.0						11	23	66	88	93	100					0.40	0.32	0.08	5.00	3.20			
Hole	89-123																							
1	3.7						34	51	85	97	100													
2	5.0						3	7	64	94	99	100					0.39	0.33	0.20	1.95	1.40			
3	10.0						3	10	61	92	98	100					0.41	0.34	0.17	2.41	1.66			
4	15.0						10	42	91	97	100						0.23	0.14	0.08	2.88	1.07			
5	19.5						8	25	69	86	96	100					0.34	0.20	0.09	3.78	1.31			
7	27.0	18.3	19	9																				10
8	34.0						7	18	83	98	100						0.37	0.26	0.11	3.36	1.66			
12	54.5						8	13	34	54	74	89	97	100			1.00	0.36	0.14	7.14	0.93			
15	69.5						7	11	38	60	76	87	97	100			0.85	0.34	0.16	5.31	0.85			
16	71.4	26.4																				Too small for testing	Sandy clay, CL	
18	79.5						13	22	56	82	96	100												
19	84.0						10	16	42	68	84	91	96	100			0.62	0.32	0.09	6.89	1.84			
23	101.3						17	22	30	38	47	57	68	83	100									
24	104.5						9	12	22	36	52	68	83	97	100		3.10	0.60	0.10	31.00	1.16			
25	110.0						9	26	73	92	98	100					0.36	0.19	0.08	4.50	1.25			

TABLE 2

SOIL CLASSIFICATION RECORD SHEET

PROJECT: Chaska Flood Control Project - Minnesota River Levee	BORING: 89-124m	MRD LAB NO. 90/135
STATION: / RANGE: / SURF. ELEV.:	DEPTH TO WATER TABLE:	BOTTOM OF HOLE:

SAMP NO.	DEPTH TO BOTTOM OF SAMP	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE SANDS 200	80	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	89-124																							
1	1.7						53	72	90	93	100													
3	9.5						4	10	71	98	100						0.41	0.32	0.17	2.41	1.47			
5	16.2						43	78	97	100														
6	19.5						4	9	46	76	89	94	98	100			0.43	0.27	0.13	2.39	0.94			
8	29.0						7	31	85	98	100						0.29	0.17	0.09	3.22	1.11			
10	36.0						6	12	36	70	88	97	100				0.60	0.34	0.14	4.29	1.38			
11	40.0						6	15	62	83	92	96	98	100			0.40	0.22	0.12	3.33	1.01			
12	44.5						7	10	18	34	56	79	96	100			2.40	0.70	0.13	13.33	1.13			
13	49.5						10	17	49	83	96	100					0.55	0.28	0.08	6.88	1.78			
14	64.5						10	15	34	56	76	89	96	100			1.00	0.36	0.07	14.29	1.85			
19	76.5						7	12	40	73	86	94	99	100			0.80	0.32	0.14	5.71	0.91			
20	80.0						15	23	39	52	75	88	97	100										
21	84.0						7	11	30	53	76	85	91	95	100		1.10	0.43	0.16	6.88	1.05			
22	85.0						69	74	84	93	97	100												
25	99.5						19	25	43	59	70	79	88	98	100									
26	105.0						7	21	92	100							0.28	0.20	0.09	3.11	1.59			
27	109.0						9	20	69	88	95	100					0.35	0.23	0.08	4.38	1.89			
28	114.5						9	26	74	97	100						0.31	0.18	0.08	3.88	1.31			
29	115.0						27	75	98	100														
30	115.7						8	29	42	66	87	98	100				0.70	0.18	0.08	8.75	0.58			
31	120.0						10	20	65	86	97	99	100				0.39	0.20	0.09	4.33	1.14			
32	121.5						12	24	89	98	100						0.30	0.19	0.07	4.29	1.72			
33	122.8	26.8																				Clayey sand SC	Too small for testing	
34	130.0						10	21	55	88	97	98	100				0.45	0.23	0.08	5.63	1.47			

TABLE 1

Figure C-33

SOIL CLASSIFICATION RECORD SHEET

PROJECT: Chaska Flood Control Project	BORING: 89-125m, 89-126mu, 89-126m and 89-130m	MRD LAB NO. 90/135

STATION:	RANGE:	SURF. ELEV.:	DEPTH TO WATER TABLE:	BOTTOM OF HOLE:

SAMP NO.	DEPTH TO BOTTOM OF SAMP	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE 200	SANDS 30	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	89-125																							
2	9.0						5	10	42	75	91	96	99	100			0.60	0.28	0.10	6.00	1.31			
3	14.0						3	13	73	93	98	99	100				0.33	0.23	0.09	3.67	1.78			
5	22.0	24.2																				Silty sand SM	Slight plasticity	
6	25.0						5	13	80	94	99	100					0.35	0.24	0.14	2.50	1.18			
7	29.0						6	14	77	96	98	99	100				0.35	0.24	0.11	3.18	1.50			
8	33.5						8	43	83	91	96	98	100				0.20	0.13	0.08	2.50	1.06			
9	35.0						6	13	39	59	81	92	99	100			0.90	0.33	0.12	7.50	1.01			
11	44.0						7	12	34	53	70	85	95	100			1.20	0.35	0.14	8.57	0.73			
14	59.0						7	13	67	87	96	100					0.35	0.22	0.12	2.92	1.15			
15	64.5						6	9	24	42	59	70	85	100			0.22	0.60	0.18	1.22	9.09			
16	69.5						10	18	55	87	96	100					0.43	0.24	0.07	6.14	1.91			
13	79.5						11	17	43	62	74	95	93	100			0.80	0.29	0.06	13.33	1.75			
20	89.0						13	19	35	55	71	85	97	100										
21	92.0						9	12	20	31	42	54	69	84	100		6.40	0.80	0.12	53.33	0.83			
22	96.0						4	7	25	55	77	86	92	96	100		0.92	0.46	0.21	4.38	1.10			
23	101.0						11	20	74	89	99	100					0.35	0.24	0.05	7.00	3.29			
25	112.0						4	12	55	84	93	97	99	100			0.41	0.31	0.15	2.73	1.56			
26	115.0						20	41	88	96	99	100												
27	117.0	16.7	28	11																				17
29	122.0						5	13	63	93	99	100					0.41	0.32	0.15	2.73	1.67			
31	127.0						23	70	91	97	100													
Hole	89-126mu																							
1	31.7	31.2	40	24																				16
2	39.0						9	13	40	64	78	84	90	100			0.65	0.32	0.14	4.64	1.13			
Hole	89-126m																							
1	1.5						18	32	53	69	80	86	96	100										
2	4.0						25	52	74	80	86	90	96	100										
5	5.7						25	37	56	70	80	87	97	100										
Hole	89-130																							
2	1.3						26	60	85	94	98	100												
4	8.7						9	13	52	92	100						0.45	0.32	0.12	3.75	1.90			
7	15.5						7	9	13	19	24	30	39	50	55	100	40.00	5.00	0.23	173.91	2.72			
18	64.0	21.4	26	9																				17

TABLE 2

Figure C-34

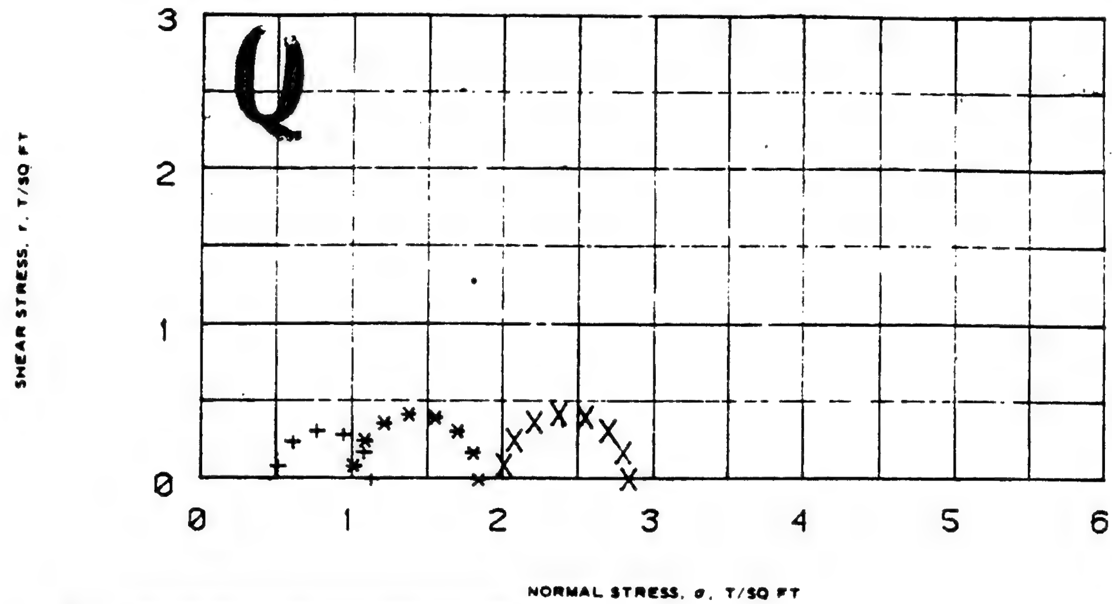
SOIL CLASSIFICATION RECORD SHEET

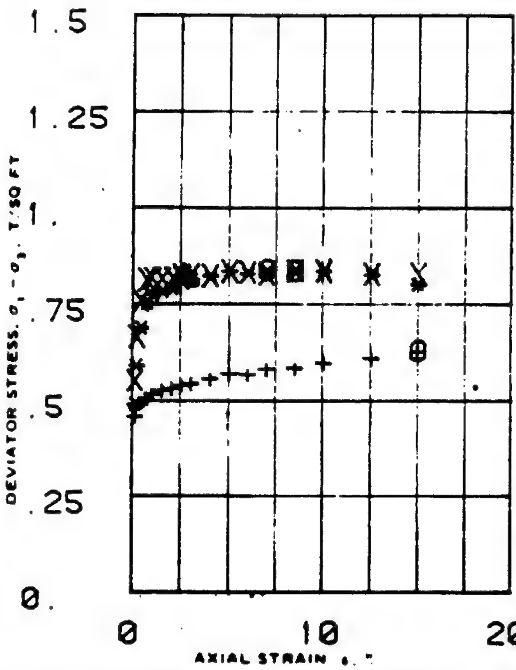
PROJECT: Chaska Flood Control Project, Minnesota River Levee (Stage 4)
BORING: 89-113M 1-5, 114M 1, 123M 20-22, 124M 18-23-24
MRD LAB NO. 90/135

STATION:
RANGE:
SURF.ELEV.:
DEPTH TO WATER TABLE:
BOTTOM OF HOLE:

SAMP NO.	DEPTH TO BOTTOM OF SAMP	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE SANDS 200	80	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	89-113M																							
1							4	15	73	93	98	99	100				0.34	0.22	0.14	2.40	1.02	Sand SP		
5							4	10	74	94	98	99	100				0.35	0.24	0.18	1.95	0.91	Sand SP		
Hole	89-114M																							
1							29	39	65	78	87	96	99	100								Silty sand SM		
Hole	89-123M																							
20							9	16	36	49	58	69	79	86	100		2.29	0.33	0.08	27.86	0.57	Silty gravelly sand SM		
22							9	13	21	33	44	61	72	92	100		4.57	0.70	0.11	43.16	1.01	Silty gravelly sand SM		
Hole	89-124M																							
18							7	13	38	66	81	91	98	100			0.71	0.33	0.13	5.44	1.16	Silty sand SM-SP		
23							7	12	32	48	60	77	91	98	100		1.93	0.39	0.14	13.97	0.57	Silty gravelly sand SM		
24							7	10	25	43	60	76	90	98	100		2.00	0.50	0.17	11.75	0.74	Silty gravelly sand SM		

TABLE 1





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	9.5	9.6	9.5	
	DRY DENSITY LB/CU FT	γ_{d_o}	113.2	113.	113.7	
	SATURATION, %	S_o	49.	49.	50.	
	VOID RATIO	e_o	.54	.54	.53	
BEFORE SHEAR	WATER CONTENT, %	w_c	19.9	20.9	20.	
	DRY DENSITY LB/CU FT	γ_{d_c}	112.	111.7	112.3	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	.55	.56	.55	
	FINAL BACK PRESSURE, T/SQ FT	u_o	7.7	7.7	7.7	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.620	.839	.837	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	32	15	19	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.620	.805	.820	
INITIAL DIAMETER, IN.		D_o	1.41	1.41	1.41	
INITIAL HEIGHT, IN.		H_o	2.99	3.	3.	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CL

LL 34	PL 13	PI 21	Gs 2.79	TYPE OF SPECIMEN REMOLDED	TYPE OF TEST Q

REMARKS: Remolded at a dry density (112 pcf) and a water content (9.5%). Similar to undisturbed direct shear specimens. All specimens were back pressure saturated before shearing.

PROJECT CHASKA FLOOD CONTROL NCS-IA-80-118-ED-HF

BORING NO 80-24M

SAMPLE NO. 2

DEPTH ELEV 10.0-11.0

LABORATORY 80/227

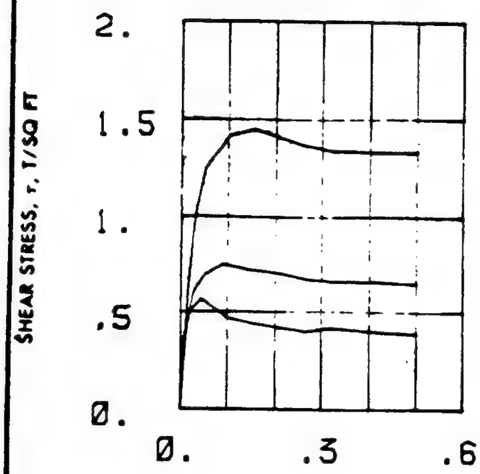
DATE 30 DEC 1980

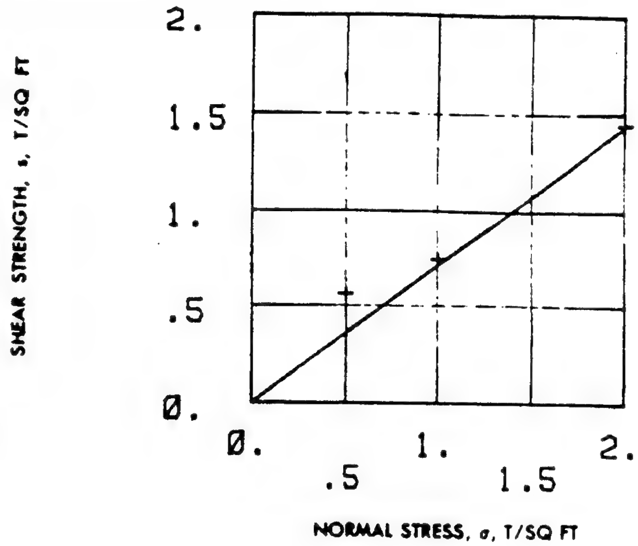
TRIAXIAL COMPRESSION TEST REPORT

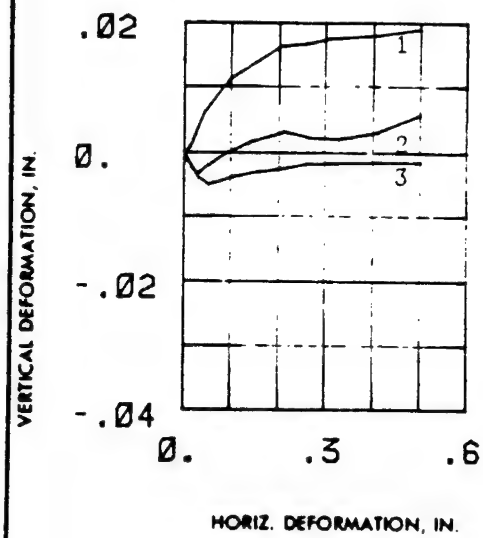
ENG FORM NO. 2089
REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 1

Figure C-36







SHEAR STRENGTH PARAMETERS

ϕ' = 35.9°

TAN ϕ' = 0.725

c' = ______ T/SQ FT

S

☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

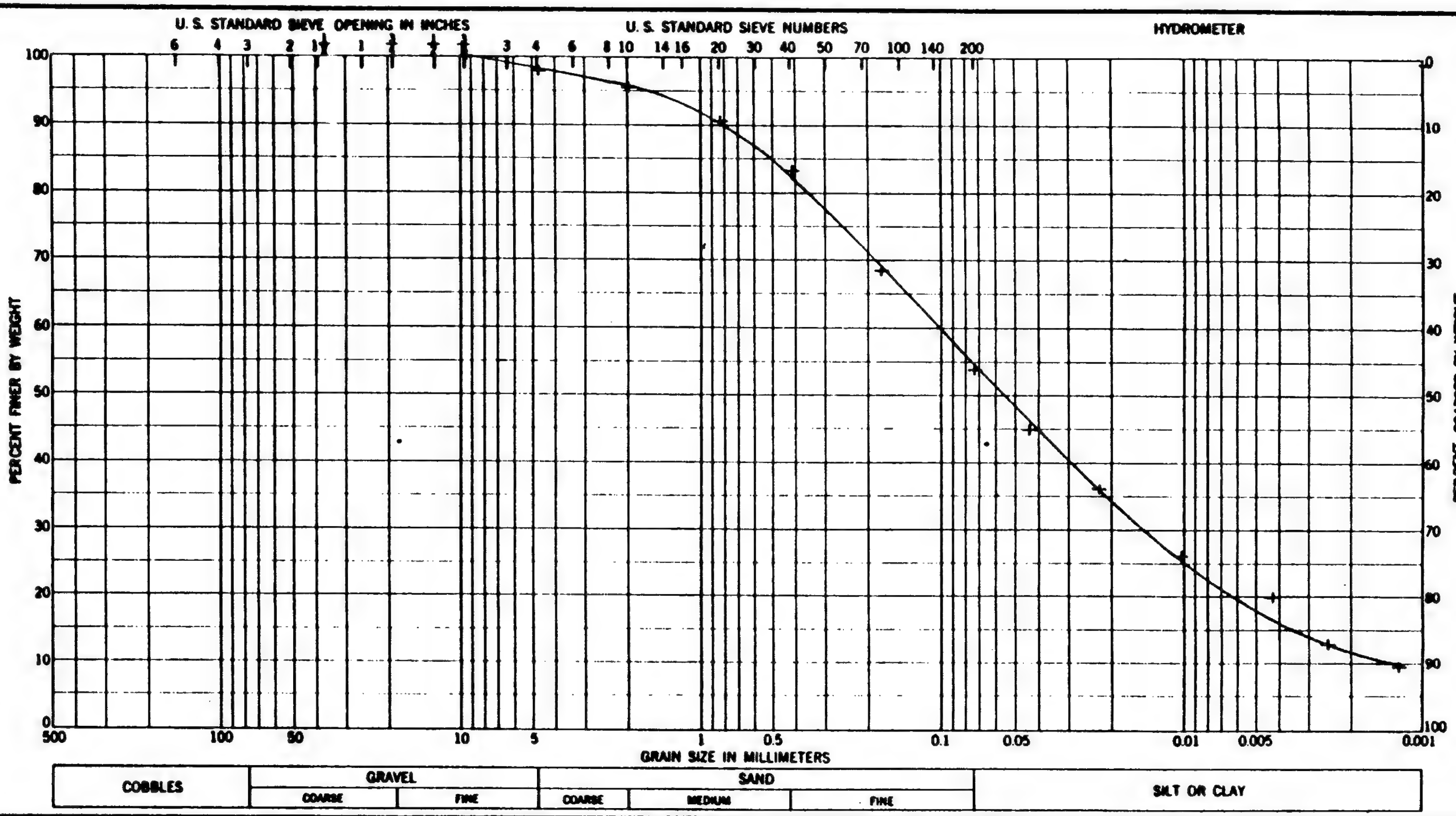
TEST NO.			1	2	3	
INITIAL	WATER CONTENT	w_o	9.9 %	8. %	8.7 %	%
	VOID RATIO	e_o	.49	.5	.51	
	SATURATION	S_o	56. %	45. %	47. %	%
	DRY DENSITY, LB/CU FT	γ_d	116.8	116.5	115.1	
VOID RATIO AFTER CONSOLIDATION		e_c	.5	.49	.48	
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	17. %	15. %	15.2 %	%
	VOID RATIO	e_f	.51	.49	.48	
	SATURATION	S_f	94. %	86. %	88. %	%
NORMAL STRESS, T/SQ FT		σ	.5	1.	2.	
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.57	.75	1.45	
ACTUAL TIME TO FAILURE, MIN		t_f	180	300	450	
RATE OF STRAIN, IN./MIN		X .0001	2.44	2.93	3.4	
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.4	.65	1.33	

TYPE OF SPECIMEN UNDISTURBED			3. IN. SQUARE	1.01 IN. THICK
CLASSIFICATION Sandy clay, CL				
LL 34	PL 13	PI 21		G_s 2.79

REMARKS Brown, brittle, hard consistency, medium strength at PL,. gloss shine, slow shake reaction, surficial cracks, highly calcareous

PROJECT CHASKA FLOOD CONTROL NCS-IA-80-118-ED-HF	
AREA MRD LAB NO: 80/227	
BORING NO. 80-24M	SAMPLE NO. 2
DEPTH EL 10.0-11.1	DATE 30 DEC 1980

DIRECT SHEAR TEST REPORT Figure C-37



Sample No.	Depth	Classification	Nat w %	LL	PL	PI
2	10.0-11.0	Sandy clay, CL		34	13	21

Project CHASKA FLOOD CONTROL

NCS-IA-80-118-ED-HF

Area MRD LAB NO. 80/227

Boring No. 80-24M

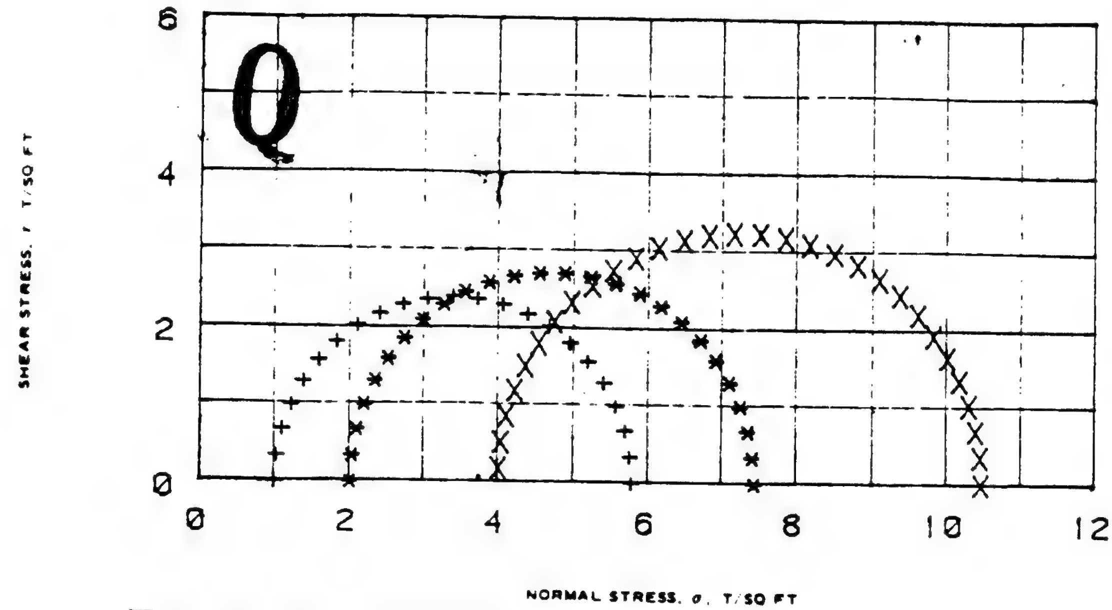
Date 30 DEC 1980

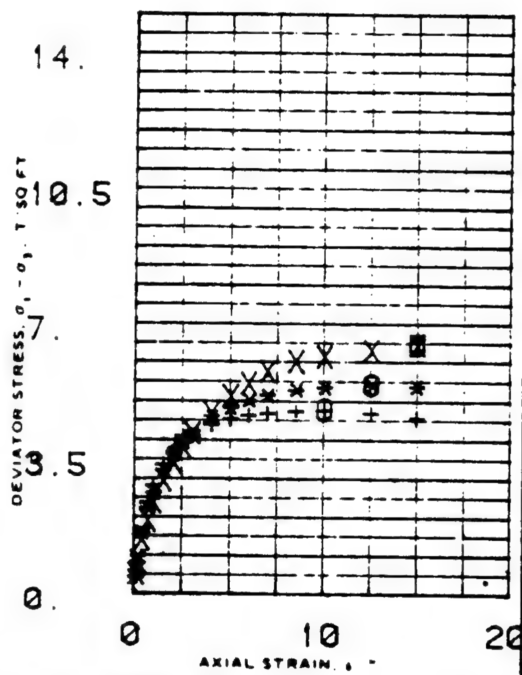
GRADATION CURVES

ENG FORM 1 MAY 63 2087

FI[illegible] 3

Figure C-38





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	18.8	18.5	18.7	
	DRY DENSITY LB/CU FT	γ_{d_o}	101.5	99.3	97.9	
	SATURATION, %	S_o	77,	71.	70.	
	VOID RATIO	e_o	.66	.7	.72	
BEFORE SHEAR	WATER CONTENT, %	w_c	18.2	18.4	18.2	
	DRY DENSITY LB/CU FT	γ_{d_c}	102.1	100.7	101.8	
	SATURATION, %	S_c	76.	74.	75.	
	VOID RATIO	e_c	.65	.67	.66	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	4.70	5.43	6.46	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	21	25	31	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	4.50	5.41	6.46	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.4	
INITIAL HEIGHT, IN		H_o	2.90	3.	2.90	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS

LL 45	PL 14	PI 31	Gs 2.7	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Dark gray, brittle, medium consistency, medium strength at PL, no shine, fast shake reaction. Assumed a specific gravity of 2.70.

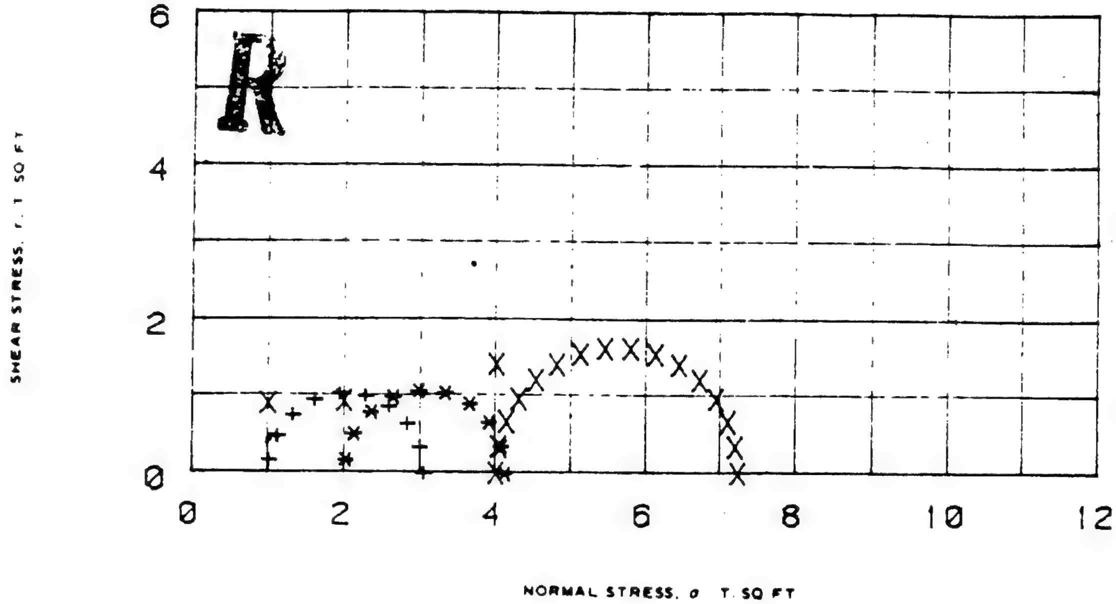
PROJECT	CHASKA FLOOD CONTROL NCS-IA-80-110-ED-HF		
BORING NO	80-26M	SAMPLE NO	2
DEPTH ELEV	20.0-21.0		
LABORATORY	80/227	DATE	30 DEC 1980

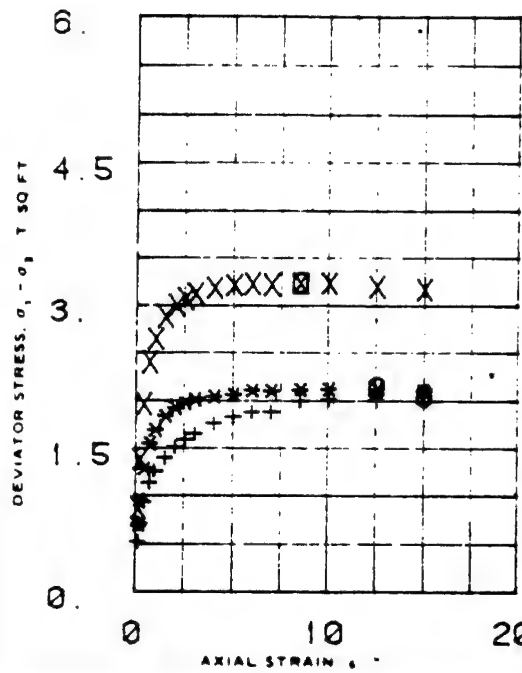
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 4

Figure C-39





			1	2	3
SPECIMEN NO			1	2	3
INITIAL	WATER CONTENT, %	w_o	19.1	18.	17.4
INITIAL	DRY DENSITY LB/CU FT	γ_{d_o}	103.4	101.2	101.5
INITIAL	SATURATION, %	S_o	77.	75.	71.
INITIAL	VOID RATIO	e_o	.63	.67	.66
BEFORE SHEAR	WATER CONTENT, %	w_c	25.6	26.2	23.9
BEFORE SHEAR	DRY DENSITY LB/CU FT	γ_{d_c}	104.9	103.7	106.9
BEFORE SHEAR	SATURATION, %	S_c	100.	100.	100.
BEFORE SHEAR	VOID RATIO	e_c	.61	.63	.58
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	5.5	5.5	5.5
MINOR PRINCIPAL STRESS, T SQ FT		σ_3	1.	2.	4.
MAXIMUM DEVIATOR STRESS, T SQ FT		$(\sigma_1 - \sigma_3)_{max}$	2.05	2.13	3.24
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	123	102	72
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	2.05	2.11	3.17
INITIAL DIAMETER, IN		D_o	1.4	1.4	1.39
INITIAL HEIGHT, IN		H_o	2.92	2.98	2.98

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS

LL 45	PL 14	PI 31	Gs 2.7	TYPE OF SPECIMEN: UNDISTURBED	TYPE OF TEST: R

REMARKS R-2 was trimmed from a different core section than R-1 and R-3.

PROJECT: CHASKA FLOOD CONTROL NCS-IA-80-110-ED-HF

BORING NO: 80-26M — SAMPLE NO: 2

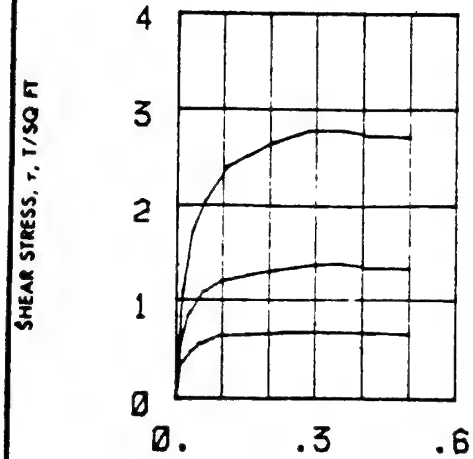
DEPTH ELEV: 20-21.8

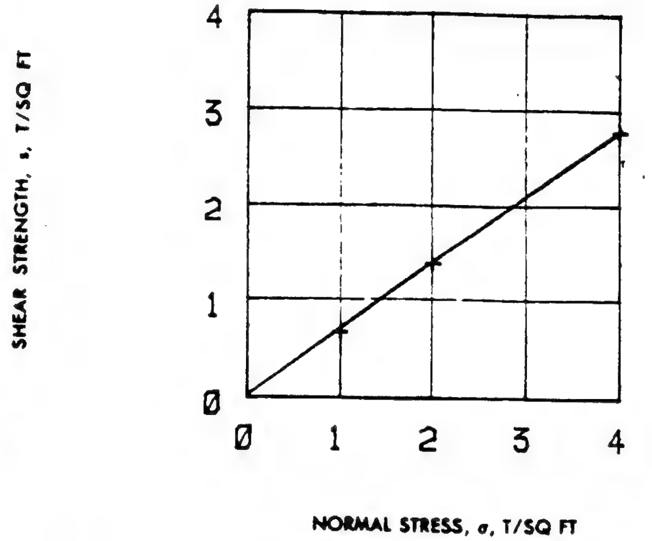
LABORATORY: 80/227 — DATE: 30 DEC 1980

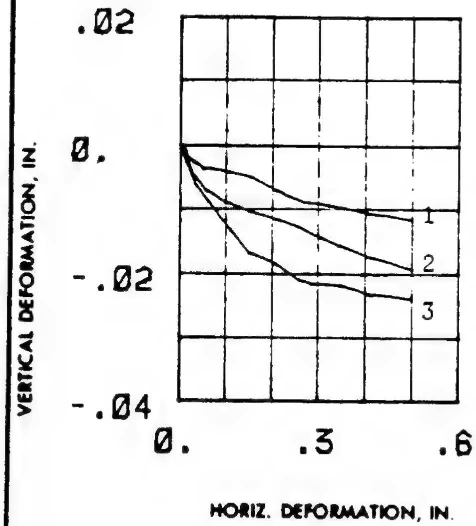
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089, REV JUNE 1970 — PREVIOUS EDITION IS OBSOLETE — TRANSLUCENT — (EM 1110-2-1906)

Figure 5







TEST NO.			1	2	3	
INITIAL	WATER CONTENT	w_o	14.5 %	14.5 %	15.7 %	%
	VOID RATIO	e_o	.85	.81	.76	
	SATURATION	S_o	46. %	48. %	56. %	%
	DRY DENSITY, LB/CU FT	γ_d	91.1	92.9	96.	
VOID RATIO AFTER CONSOLIDATION		e_c	.82	.81	.65	
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	29.2%	27.8 %	22.2 %	%
	VOID RATIO	e_f	.79	.75	.57	
	SATURATION	S_f	100 %	100 %	100. %	%
NORMAL STRESS, T/SQ FT		σ	1.	2.	4.	
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.68	1.39	2.79	
ACTUAL TIME TO FAILURE, MIN		t_f	630	990	690	
RATE OF STRAIN, IN./MIN		X .0001	3.63	3.46	4.09	
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.65	1.33	2.71	

SHEAR STRENGTH PARAMETERS

ϕ' = 34.9°

TAN ϕ' = 0.698

c' = ______ T/SQ FT

S

☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TYPE OF SPECIMEN UNDISTURBED			3. IN. SQUARE	.506 IN. THICK
CLASSIFICATION				
LL 45	PL 14	PI 31		G_s 2.7

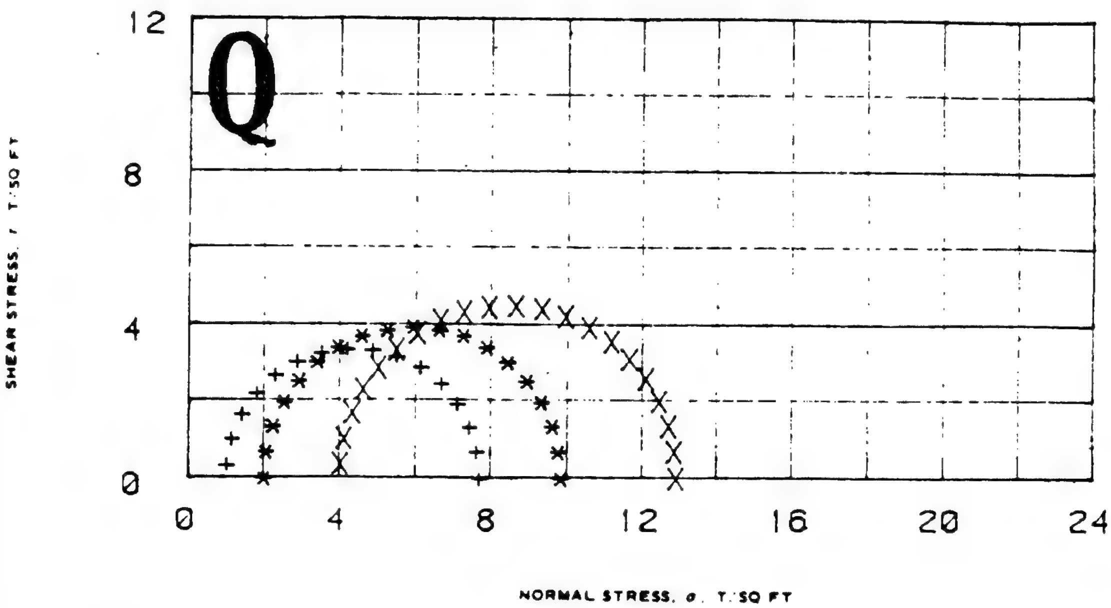
REMARKS

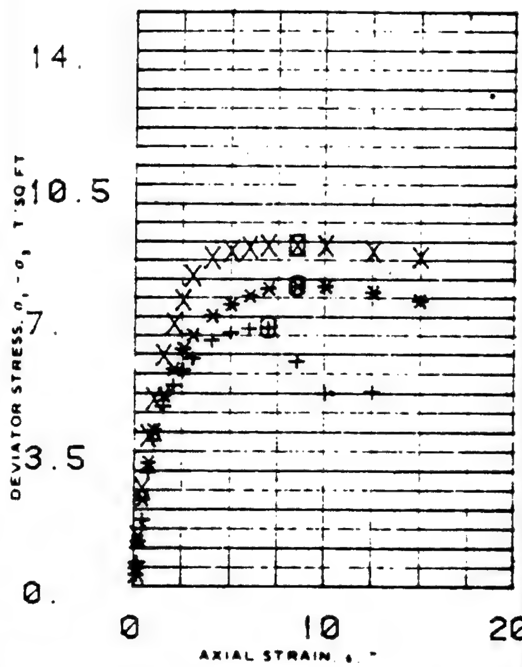
PROJECT	CHASKA FLOOD CONTROL NCS-IA-80-118-ED-HF
AREA	NRD LAB NO: 80/227
BORING NO. 80-26M	SAMPLE NO. 2
DEPTH EL 20.0-21.0	DATE 30 DEC 1980

DIRECT SHEAR TEST REPORT

Figure C-41

ENG FORM





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	19.2	18.2	19.1	
	DRY DENSITY LB/CU FT	γd_o	107.1	108.1	108.2	
	SATURATION, %	S_o	90.	89.	88.	
	VOID RATIO	e_o	.57	.56	.59	
BEFORE SHEAR	WATER CONTENT, %	w_c	19.2	18.5	18.6	
	DRY DENSITY LB/CU FT	γd_c	107.5	108.8	107.3	
	SATURATION, %	S_c	91.	90.	88.	
	VOID RATIO	e_c	.57	.56	.57	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	6.71	7.85	8.9	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	17	20	21	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	5.	7.46	8.59	
INITIAL DIAMETER, IN.		D_o	1.4	1.39	1.39	
INITIAL HEIGHT, IN		H_o	2.97	3.	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS

LL 42	PL 15	PI 27	Gs 2.7	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Gray, brittle, medium consistency, high strength at PL, dull shine, slow shake reaction. Assumed a specific gravity of 2.70.

PROJECT CHASKA FLOOD CONTROL NCS-IA-80-110-ED-H

BORING NO 80-26M

SAMPLE NO. 3

DEPTH ELEV 30.0-31.9

LABORATORY 80/227

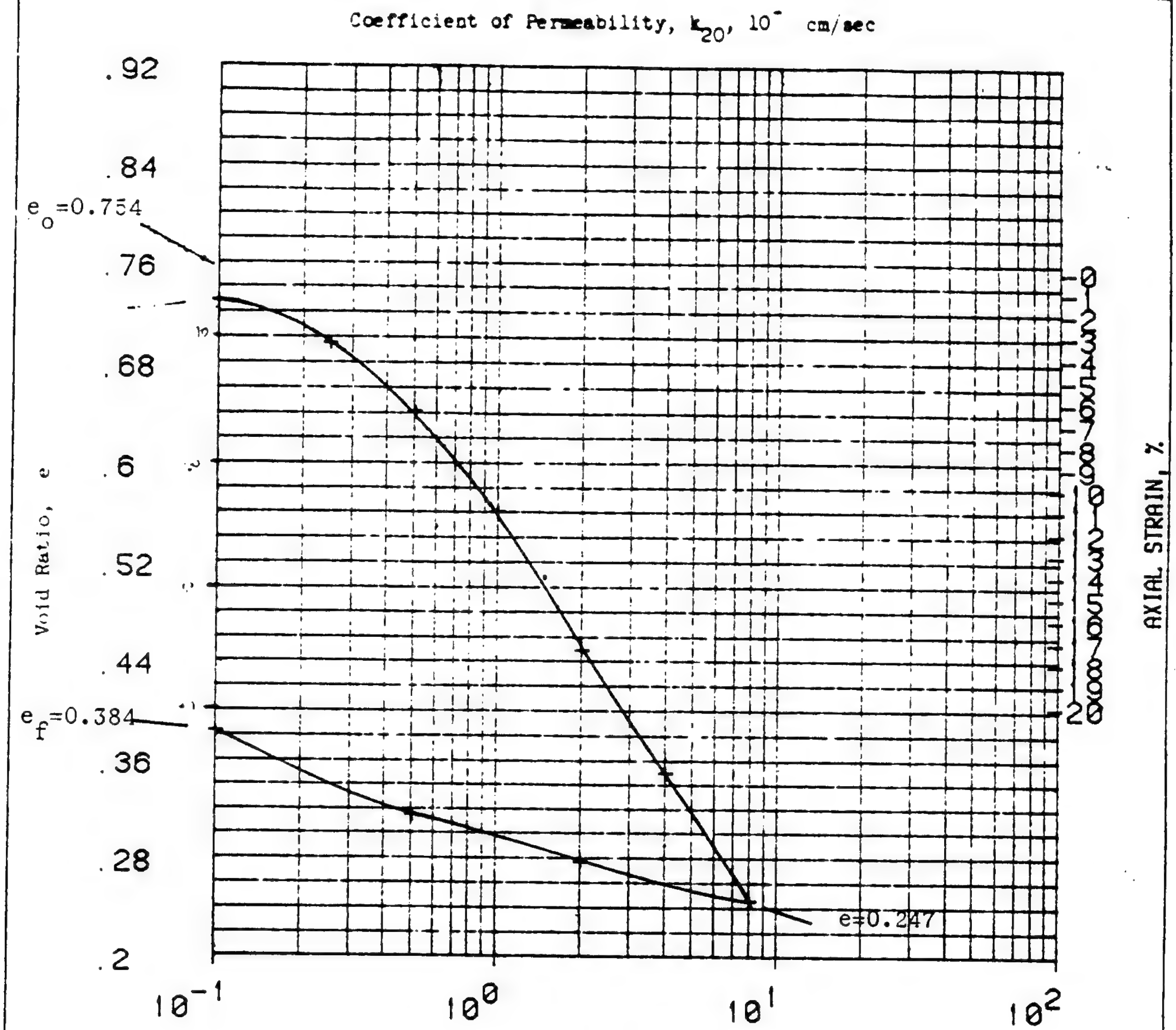
DATE 3 0 DEC 1980

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 7

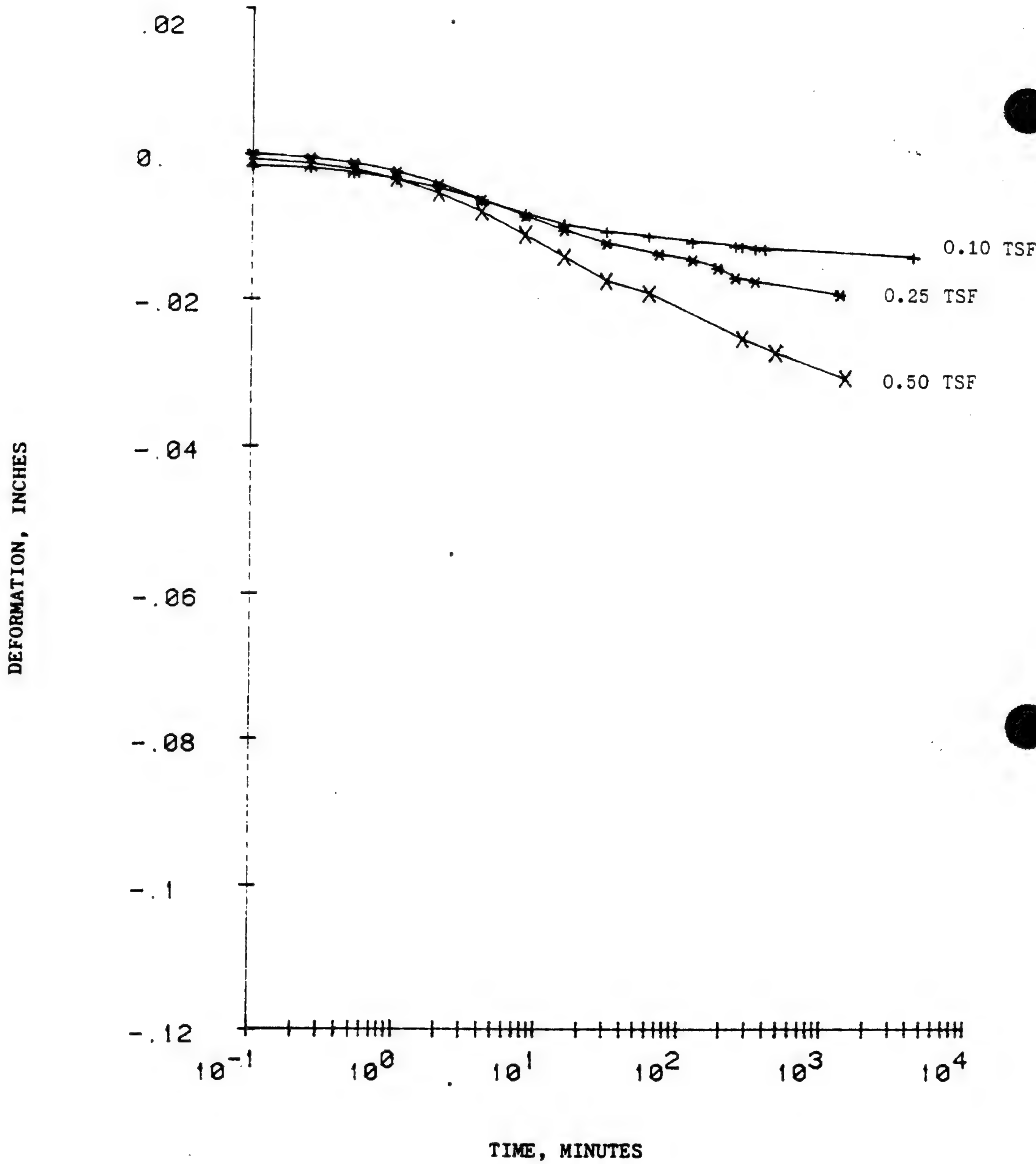
Figure C-42



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.28 in.	Ht 1. in.	Water Content, w_o	6.9 %	w_f	4.7 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	.75	e_f	.38
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	23. %	S_f	31. %
Compression Index, C_c		Dry Density, γ_d	91.1 lb/ft^3		
Classification Organic, OH		k_{20} at e_o = x 10^{-} cm/sec			
LL 86	G_s 2.56	Project CHASKA NCS-IA-82-126-ED-GH			
PL 39	D_{10}				
Remarks Note the secondary		Area MRD LAB NO: 83/67			
compression of Figures 7 & 8.		Boring No. 82-41MU		Sample No. 2	
		Depth El		Date 17 FEB 1983	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 6



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67

DATE: 17 FEB 1983

BORING NO: 82-41MU

SAMPLE NO: 2

DEPTH/ELEV: .

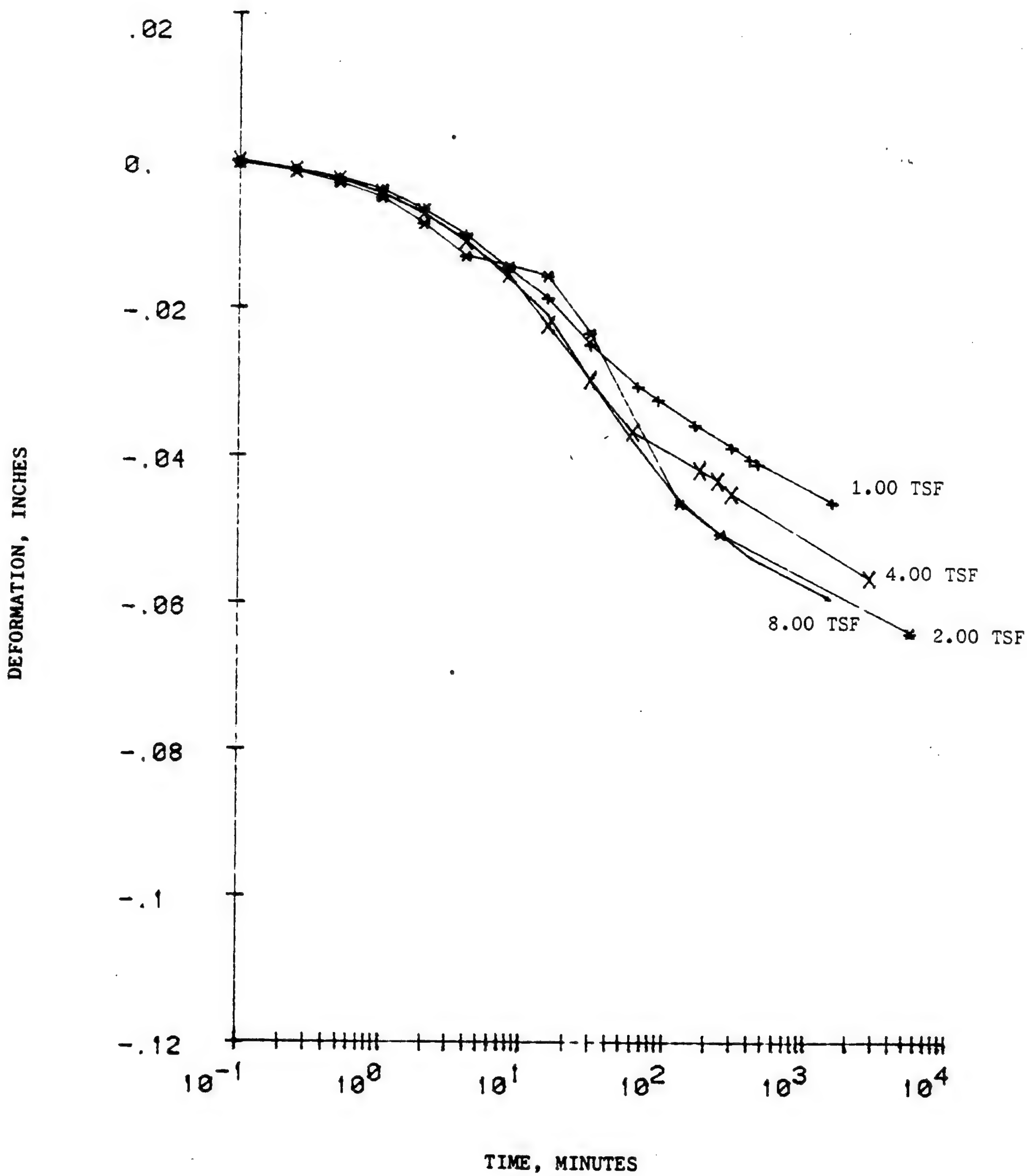
COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 7

Figure C-44

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67

DATE: 17 FEB 1983

BORING NO: 82-41MU

SAMPLE NO: 2

DEPTH/ELEV: .

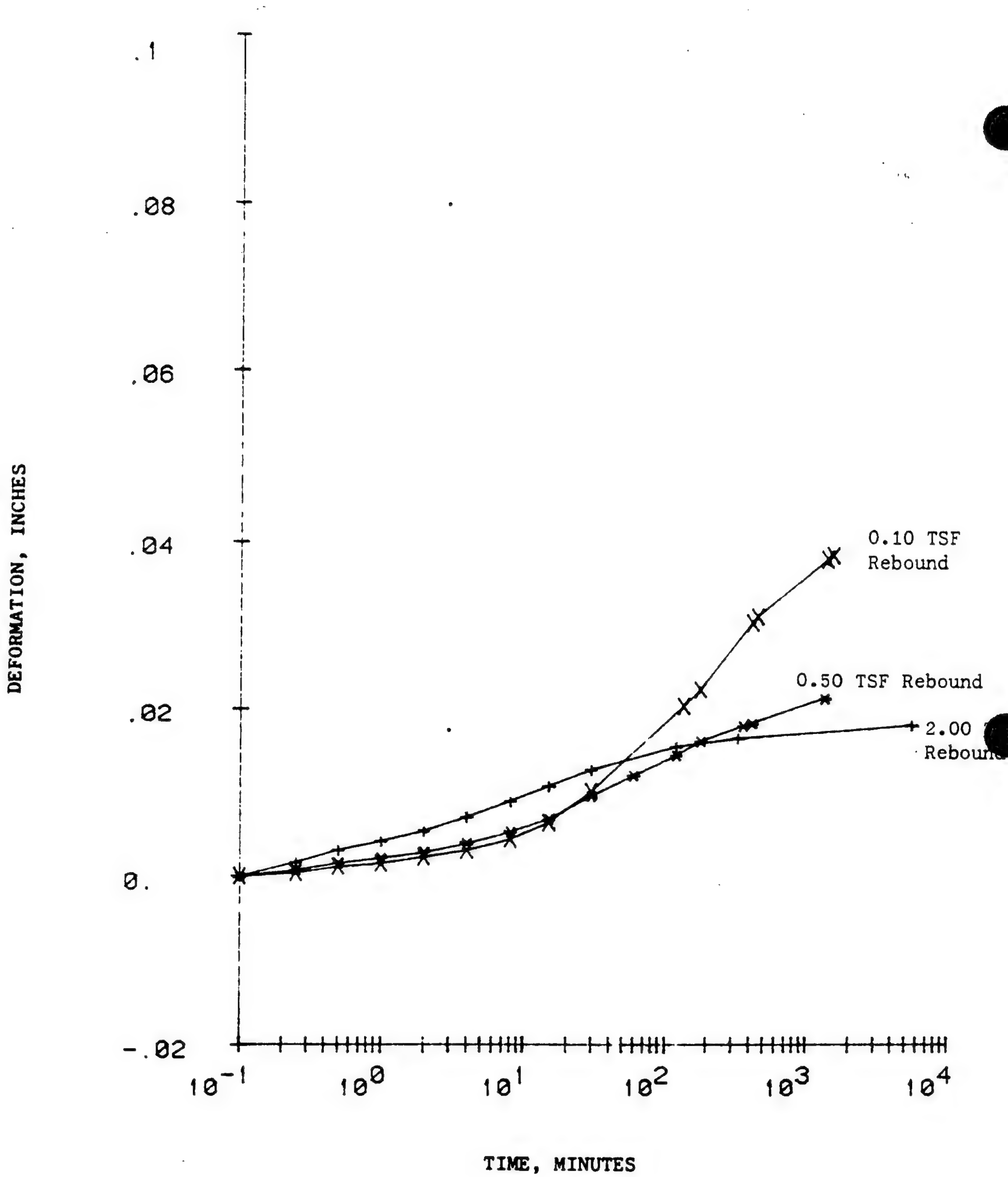
COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 8

Figure C-45

MRD Form 956, 1 May 80



PROJECT:	CHASKA NCS-IA-82-126-ED-GH		
MRD LAB NO:	83/67	DATE:	17 FEB 1983
BORING NO:	82-41MU SAMPLE NO: 2	DEPTH/ELEV:	.

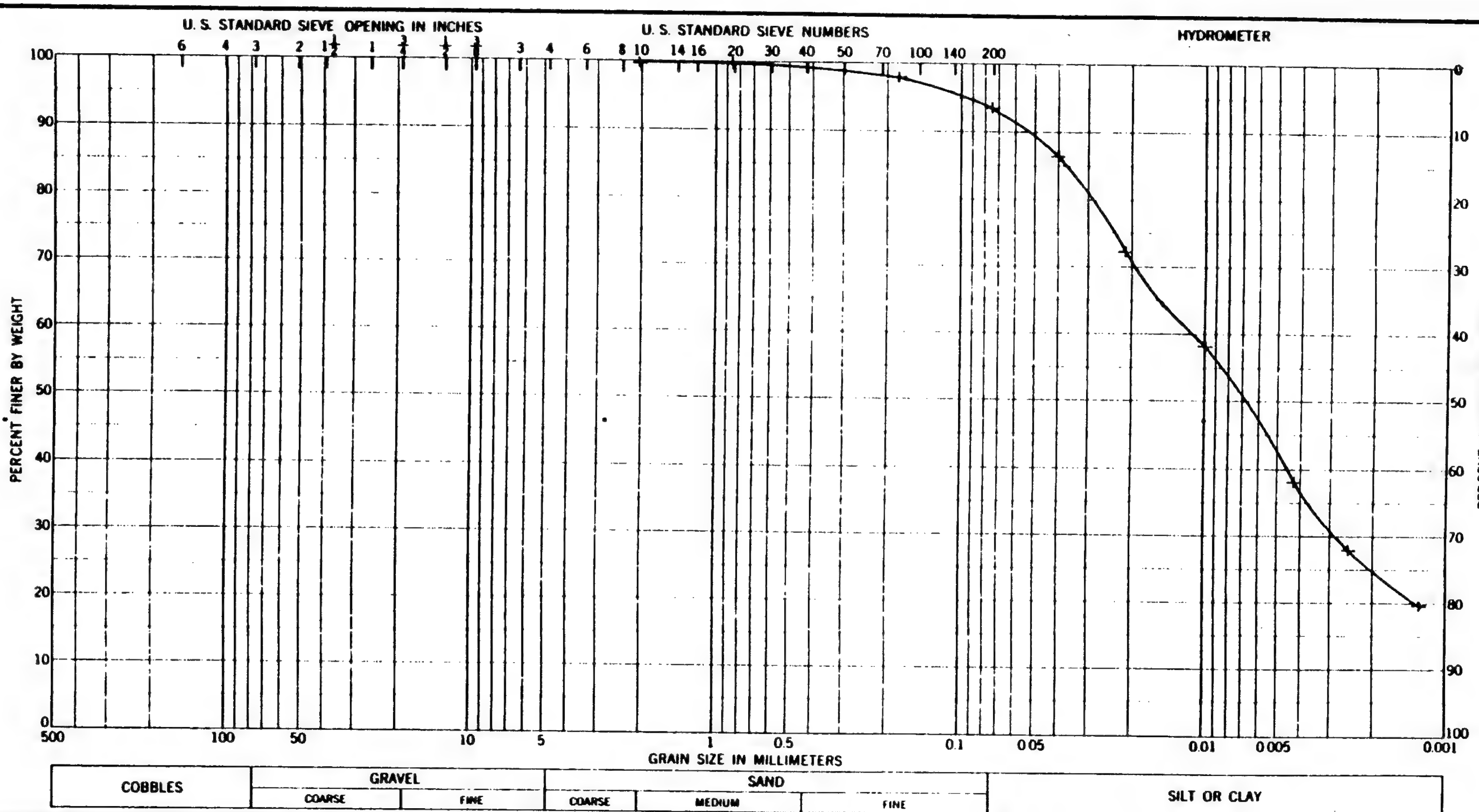
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 9

Figure C-46

MRD Form 956, 1 May 80



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2		Organic, OH		86	39	47

Project CHASKA

Area MRD LAB NO. 83/67

Boring No. 82-41 MU

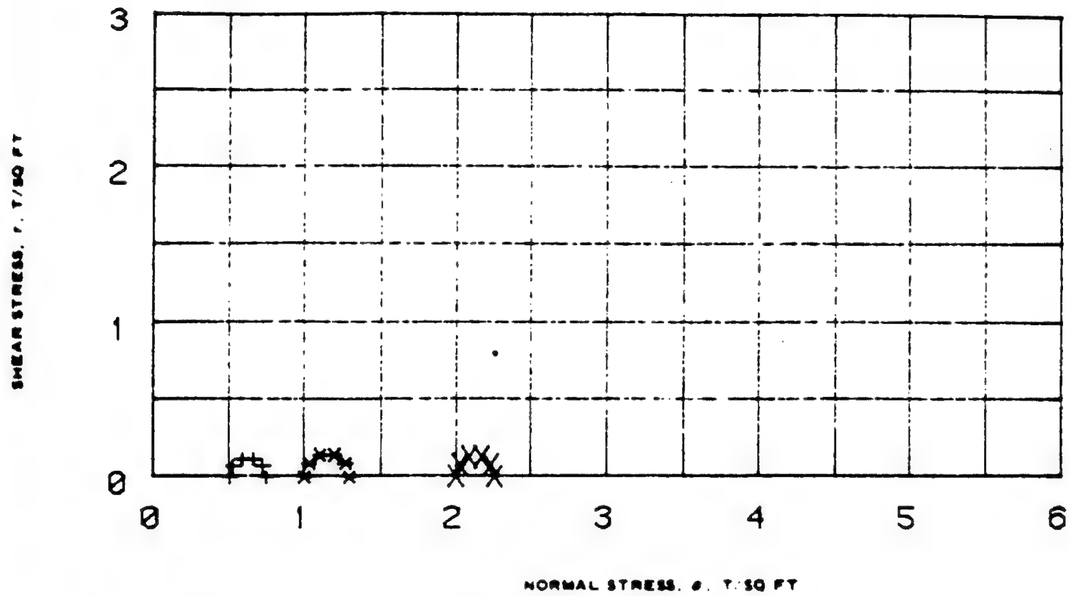
Date 17 FEB 1983

GRADATION CURVES

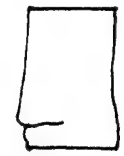
ENG FORM 1 MAY 63 2087

FIGURE 10

Figure C-47

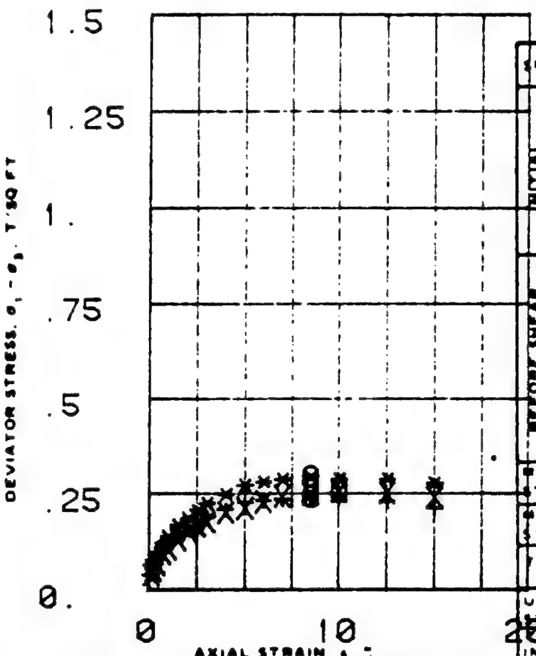


Q-1



Q-2

Q-3



SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	68.5	70.0	69.	
	DRY DENSITY LB/CU FT	γ_{d_o}	59.2	58.1	59.8	
	SATURATION, %	S_o	100.	100.	[illegible]	
	VOID RATIO	e_o	1.7	1.76	[illegible]	
BEFORE SHEAR	WATER CONTENT, %	w_c	68.3	70.5	[illegible]	
	DRY DENSITY LB/CU FT	γ_{d_c}	59.2	58.1	59.3	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	1.7	1.75	[illegible]	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.246	.297	.257	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	15	15	20	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.214	.20	.242	
INITIAL DIAMETER, IN		D_o	1.38	1.4	1.38	
INITIAL HEIGHT, IN		H_o	2.96	2.94	2.96	

CONTROLLED- TEST

DESCRIPTION OF SPECIMENS Organic, OH

LL 86	PL 39	PI 47	Gs 2.58	TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	Q

REMARKS: Gray, soft consistency, low strength at PL, no shine, fast shake response, calcareous.

PROJECT CHASKA NCS-IA-82-128-ED-GH

BORING NO 82-41 SAMPLE NO 2

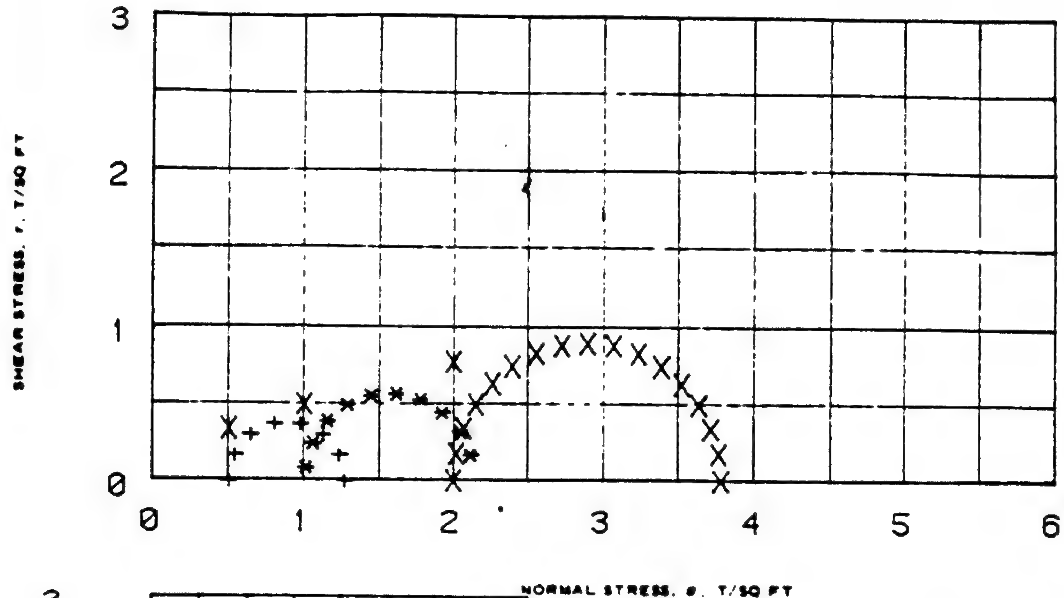
DEPTH ELEV .

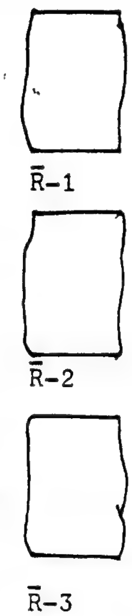
LABORATORY 85/87 DATE 17 FEB 1983

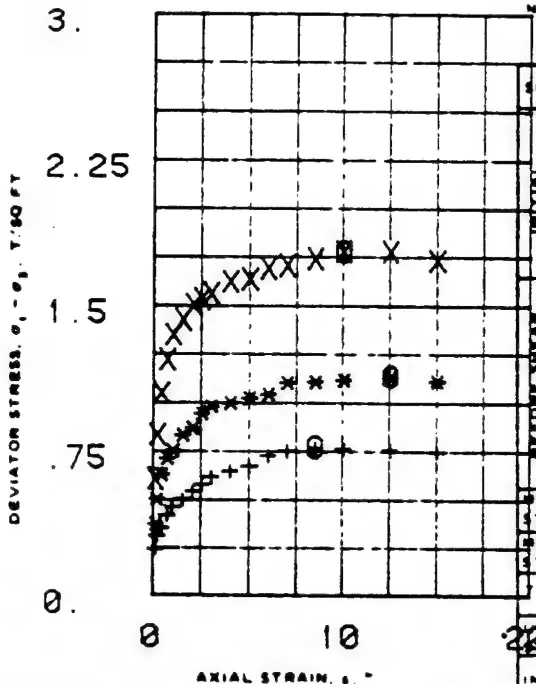
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 1







SPECIMEN NO			1	2	3	
INITIAL	WATER CONTENT %	w_o	69.2	71.3	66.7	
	DRY DENSITY LB/CU FT	γ_{d_o}	57.7	56.8	59.3	
	SATURATION %	S_o	100.	100.	100.	
	VOID RATIO	e_o	1.77	1.81	1.69	
BEFORE SHEAR	WATER CONTENT %	w_c	58.9	56.6	46.4	
	DRY DENSITY LB/CU FT	γ_{d_c}	61.6	64.	71.0	
	SATURATION %	S_c	94.	97.	97.	
	VOID RATIO	e_c	1.6	1.5	1.23	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.1	4.1	4.1	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.773	1.14	1.78	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	895	1015	700	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.755	1.12	1.74	
INITIAL DIAMETER IN		D_o	1.4	1.4	1.4	
INITIAL HEIGHT IN		H_o	3.	3.	3.	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Organic, OH

LL 86	PL 39	PI 47	G_s 2.58	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST $\bar{R}$

REMARKS B value = 0.95

PROJECT CHASKA NCS-IA-82-126-ED-GH

BORING NO 41 | SAMPLE NO. 2

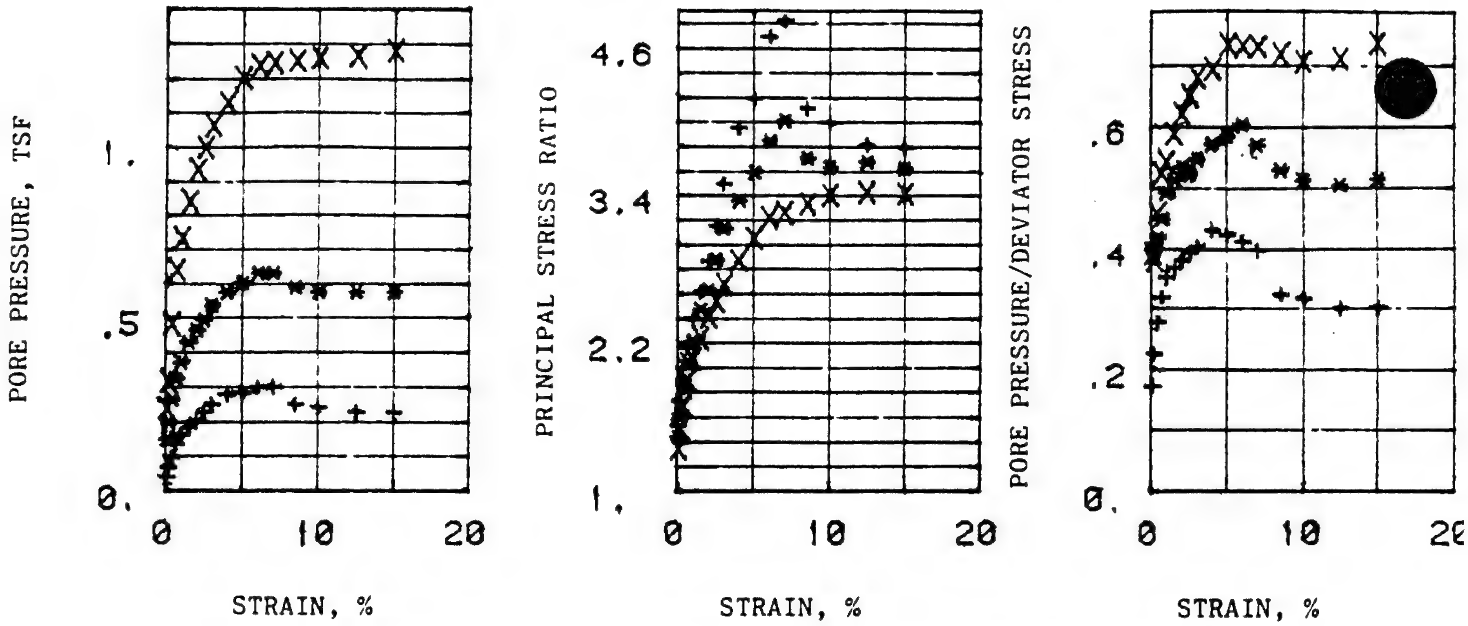
DEPTH ELEV 5.0-6.7

LABORATORY 83/87 | DATE 17 FEB 1983

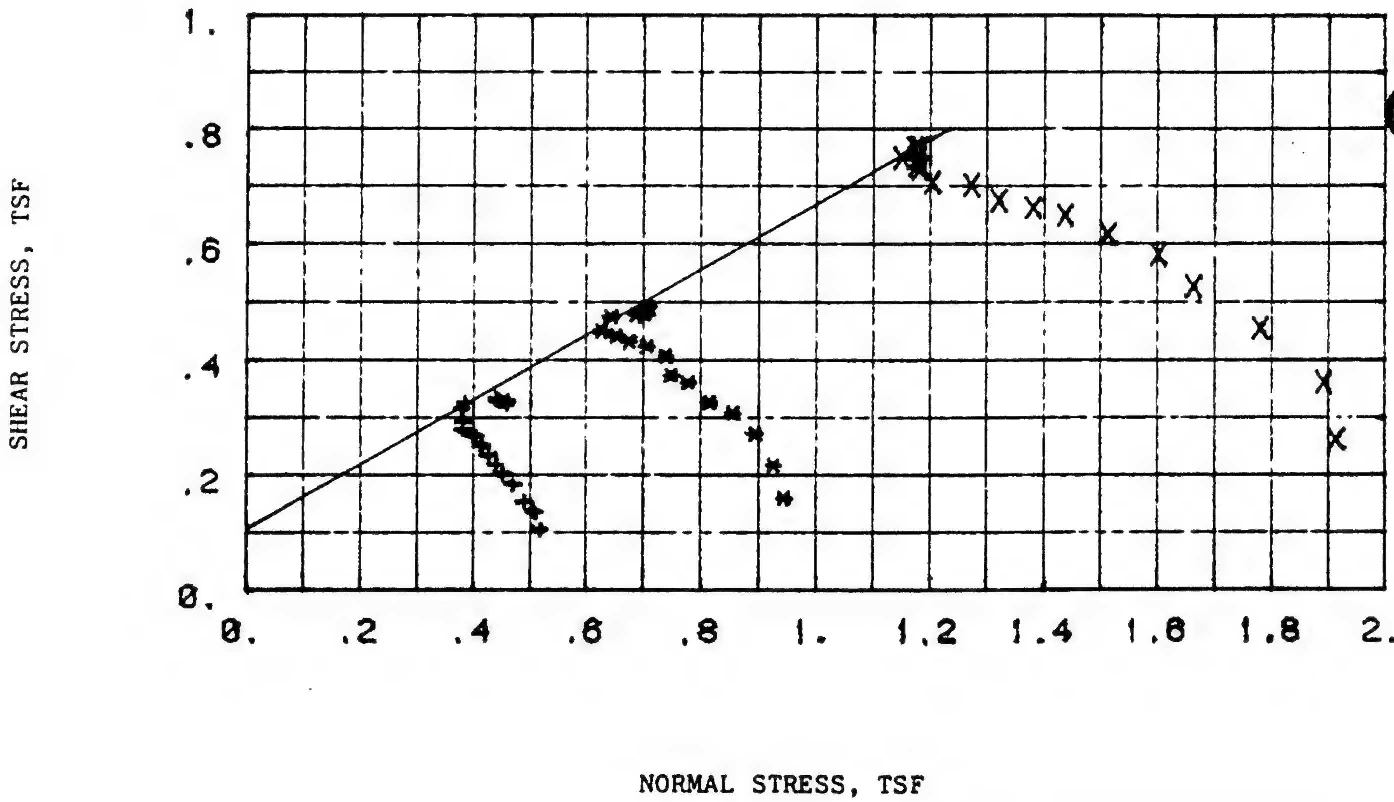
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)*
REV JUNE 1970

Figure 2



EFFECTIVE STRESS VECTOR CURVES ON 60. DEGREE PLANE



REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

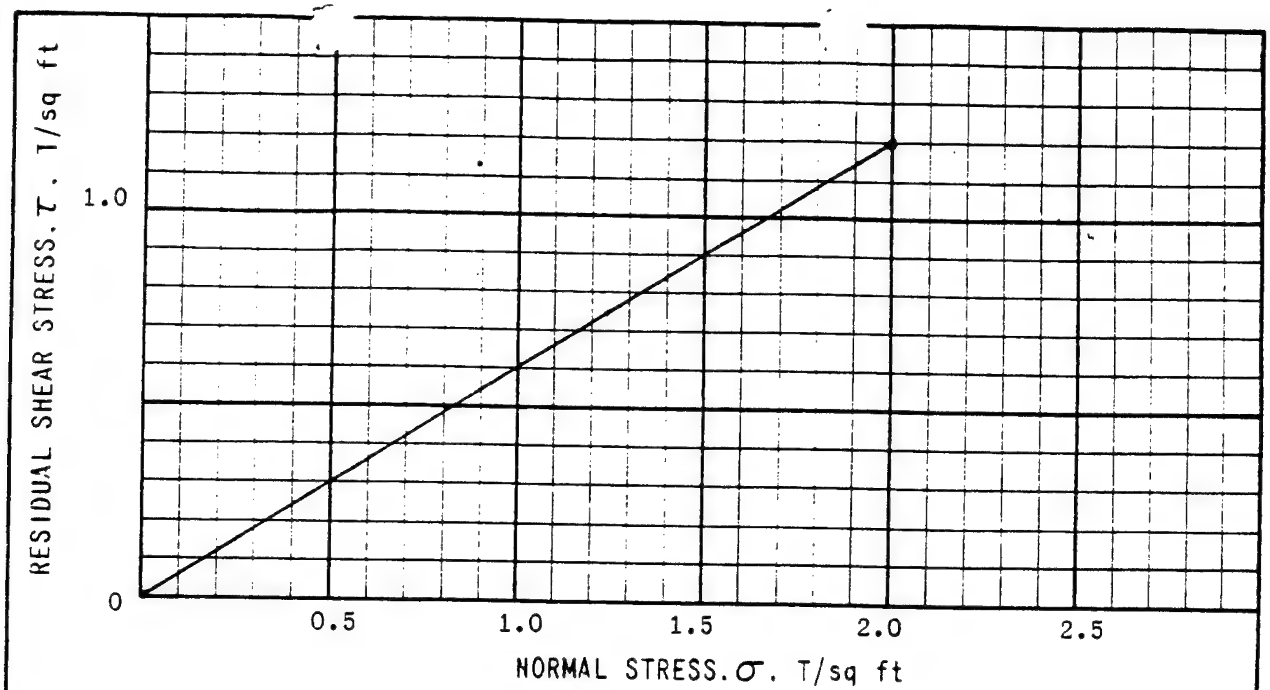
MRD Form 756, 1 May 80

PROJECT: CHASKA NCS-1A-82-126-CD-SH
BORING NO: 41 SAMPLE NO: 2
DEPTH/ELEV: 5.5-6.7
MRD LAB NO: 83/87 DATE: 17 FEB 1983

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 3

Figure C-50



TEST NO.		1			RESIDUAL SHEAR STRESS. T/sq ft	1.20		
INITIAL: WATER CONTENT	w_o	44.7			τ/σ AT RESIDUAL	0.60		
INITIAL: VOID RATIO	e_o	1.12			TIME TO RESIDUAL. days	20.7		
INITIAL: SATURATION	S_o	100			DISPLACEMENT TO RESIDUAL. inches	7.99		
INITIAL: DRY DENSITY. lb/cu ft	γ_d	75.4			FINAL SHEAR STRESS. T/sq ft	1.18		
SPECIFIC GRAVITY	G_s	2.56			FINAL DISPLACEMENT. inches	8.43		
LIQUID LIMIT	LL	86			LENGTH OF TEST. days	26.9		
PLASTIC LIMIT	PL	39			MATERIAL EXTRUDED. gms	11.9		
WATER CONTENT	w_f	28.6			MATERIAL EXTRUDED.	6.7		
NORMAL STRESS. T/sq ft	σ	2.0			SHEAR STRENGTH PARAMETERS: Φ MAXIMUM	-		
MAXIMUM SHEAR STRESS. T/sq ft	τ_{max}	-			SHEAR STRENGTH PARAMETERS: Φ RESIDUAL	31.0°	*	
DISPLACEMENT TO MAXIMUM. inches		-			SHEAR STRENGTH PARAMETERS: COHESION T/sq ft			

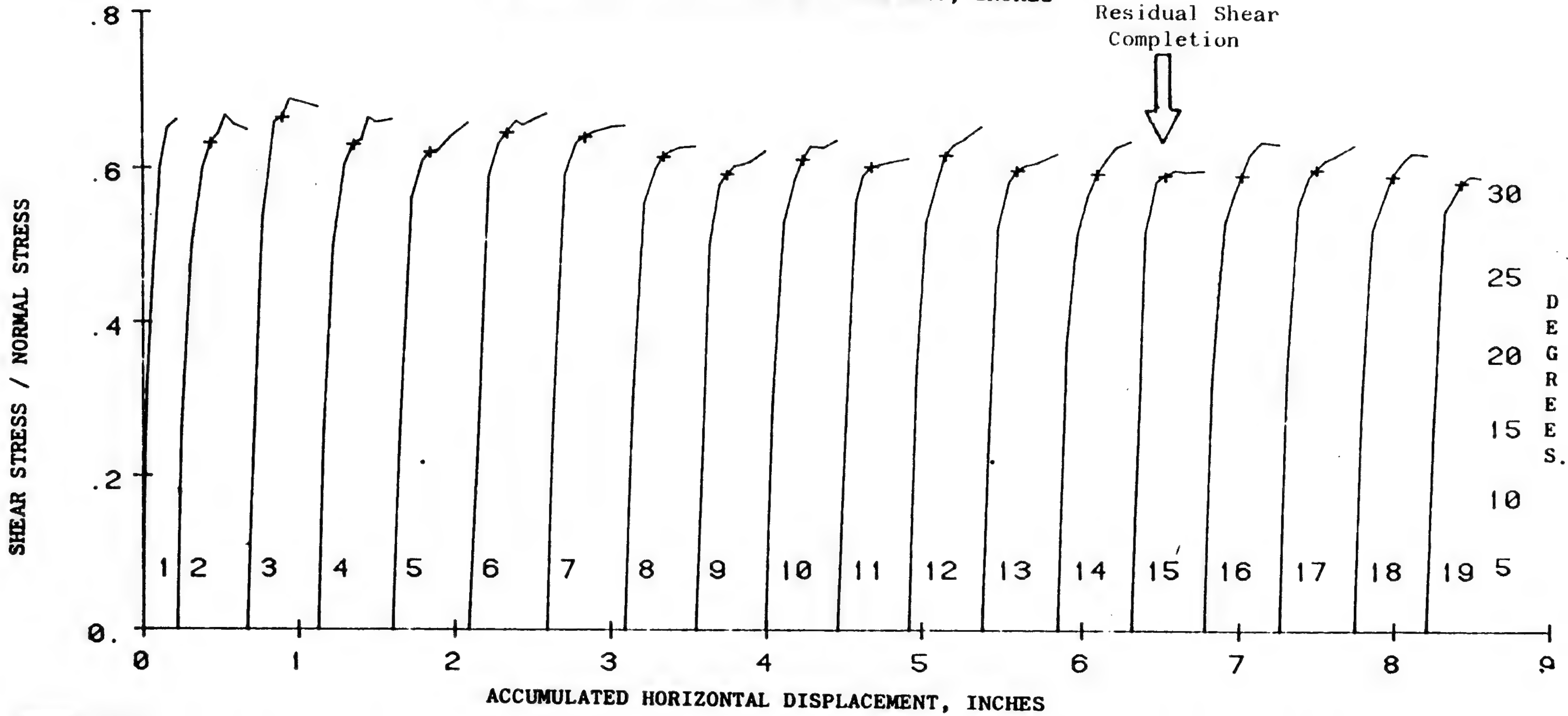
SPECIMEN DIMENSIONS 3.0 IN. SQUARE 0.5 IN. THICK.	MISSOURI RIVER DIVISION LABORATORY OMAHA NEBRASKA
CONTROLLED ☒ STRAIN ☐ STRESS	PROJECT CHASKA LAB. NO. 83/67
TYPE OF SPECIMEN Undisturbed, precut	AREA
CLASSIFICATION Organic, OH	BORING NO. 82-41 SAMPLE NO. 2
*The residual shear test is meant for testing hard shales and the results may not be meaningful on this material.	DEPTH ELEVATION 5.0-6.7 DATE 17 FEB 1983
	RESIDUAL DIRECT SHEAR TEST REPORT

MRD FORM 1 NOV 68 769

Figure 4

Figure C-51

SHEAR STRESS/NORMAL STRESS
VS.
ACCUMULATED HORIZONTAL DISPLACEMENT, INCHES



PULL NO:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
IN./DAY:	.22	.40	.15	.40	.49	.53	.52	.15	.45	.47	.46	.46	.16	.47	.51	.47	.47	.16	.53

SPECIMEN TYPE: UNDISTURBED, PRECUT

NORMAL STRESS, T/SF: 2.0

REMARKS:

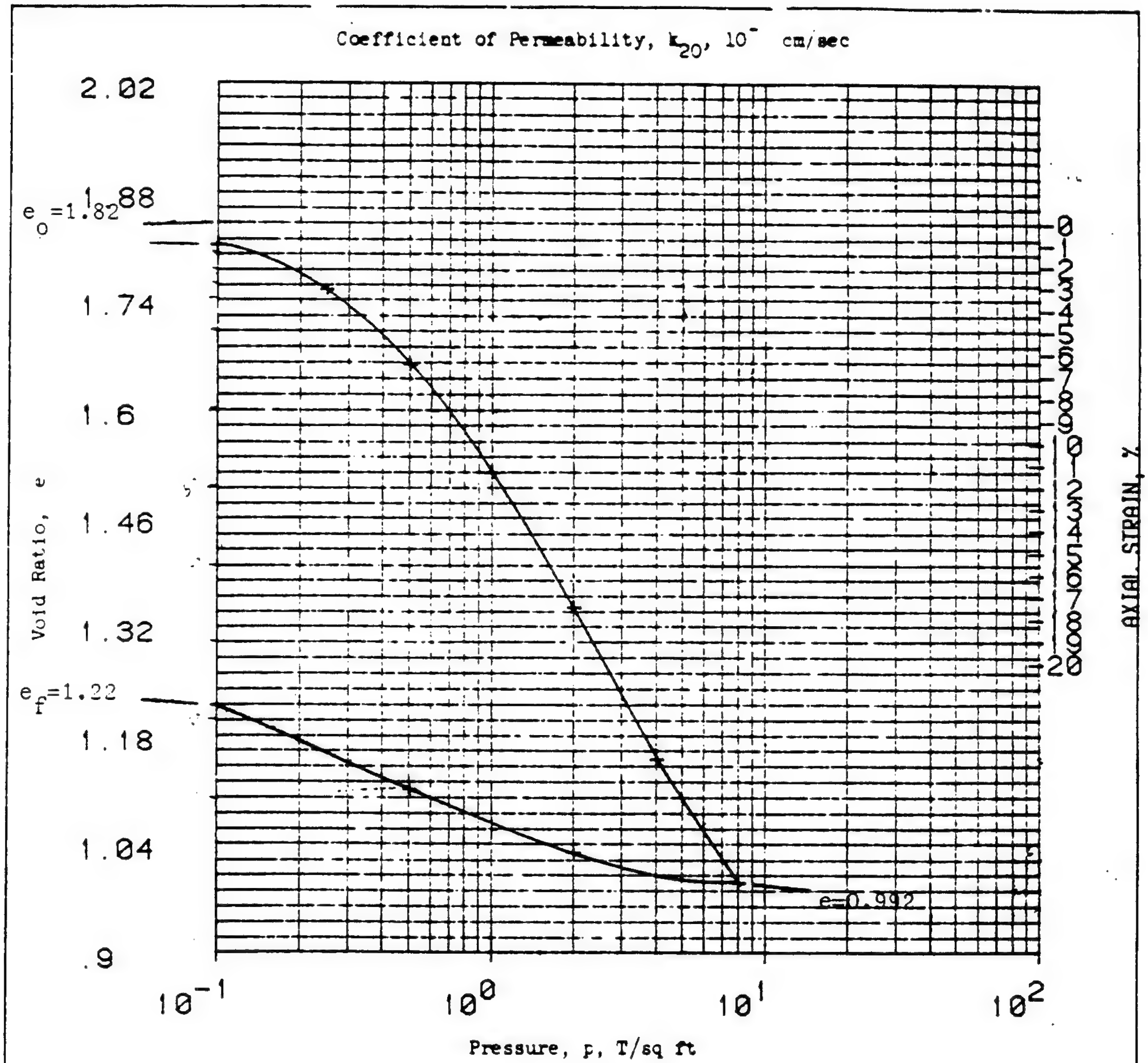
PROJECT: CHASKA
BORING NO: 82-14 SAMPLE NO: 2
DEPTH: 5.8-6.7
MRD LAB NO: 83/87 DATE: 17 FEB 1983

RESIDUAL DIRECT SHEAR TEST REPORT

FIGURE: 5

MRD Form 69, 1 May 80 (Replaces 1 Nov 68 edition)

Figure C-52



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.29 in.	Ht .999 in.	Water Content, w_o	59.6 %	w_f	53.6 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.84	e_f	1.22
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	84. %	S_f	100. %
Compression Index, C_c		Dry Density, γ_d	57.1 lb/ft^3		
Classification Fat clay, CH (Organic		k_{20} at e_o = × 10^{-} cm/sec			

LL 81	G_s 2.6
PL 32	D_{10}

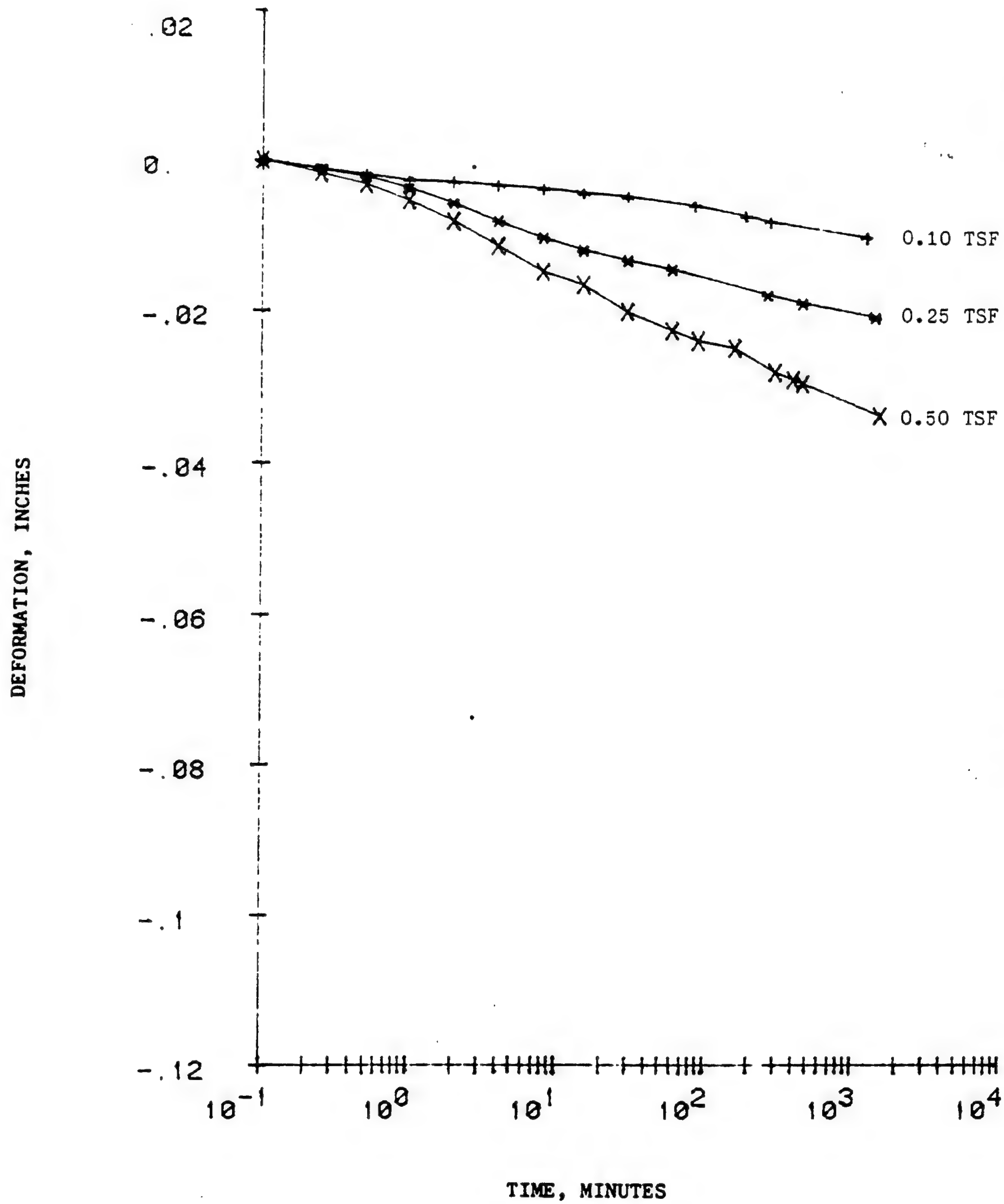
Remarks

Project CHASKA NCS-IA-82-126-FD-GH	
Area MRD LAB NO: 83/67	
Boring No. 82-41MU	Sample No. 3
Depth El 10.0-12.0	Date 17 FEB 1983

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 16



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 66/67 DATE: 17 FEB 1983

BORING NO: 82-41MU SAMPLE NO: 3 DEPTH/ELEV: 10.0-12.0

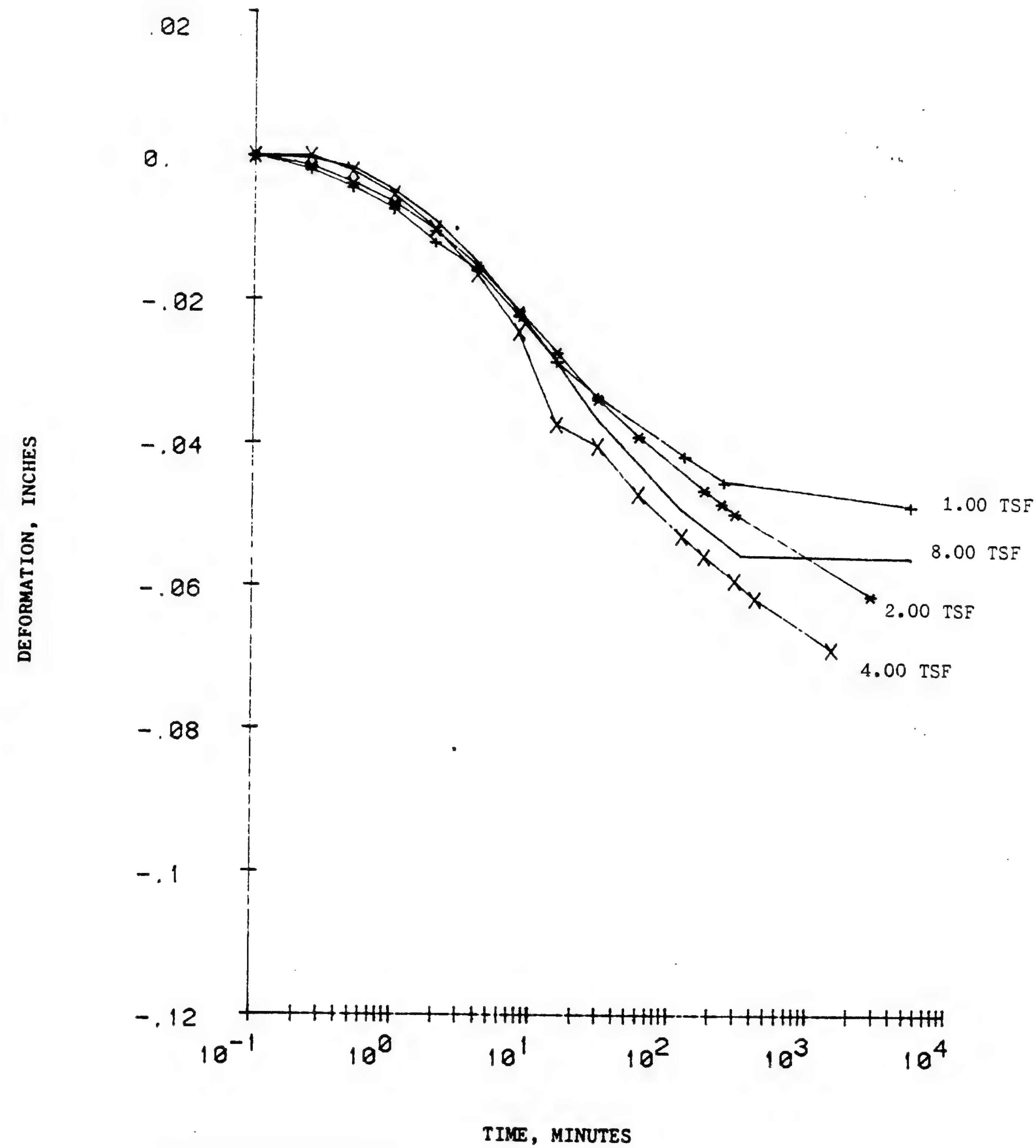
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 17

Figure C-54

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67

DATE: 17 FEB 1983

BORING NO: 82-41MU **SAMPLE NO:** 3

DEPTH/ELEV: 10.0-12.0

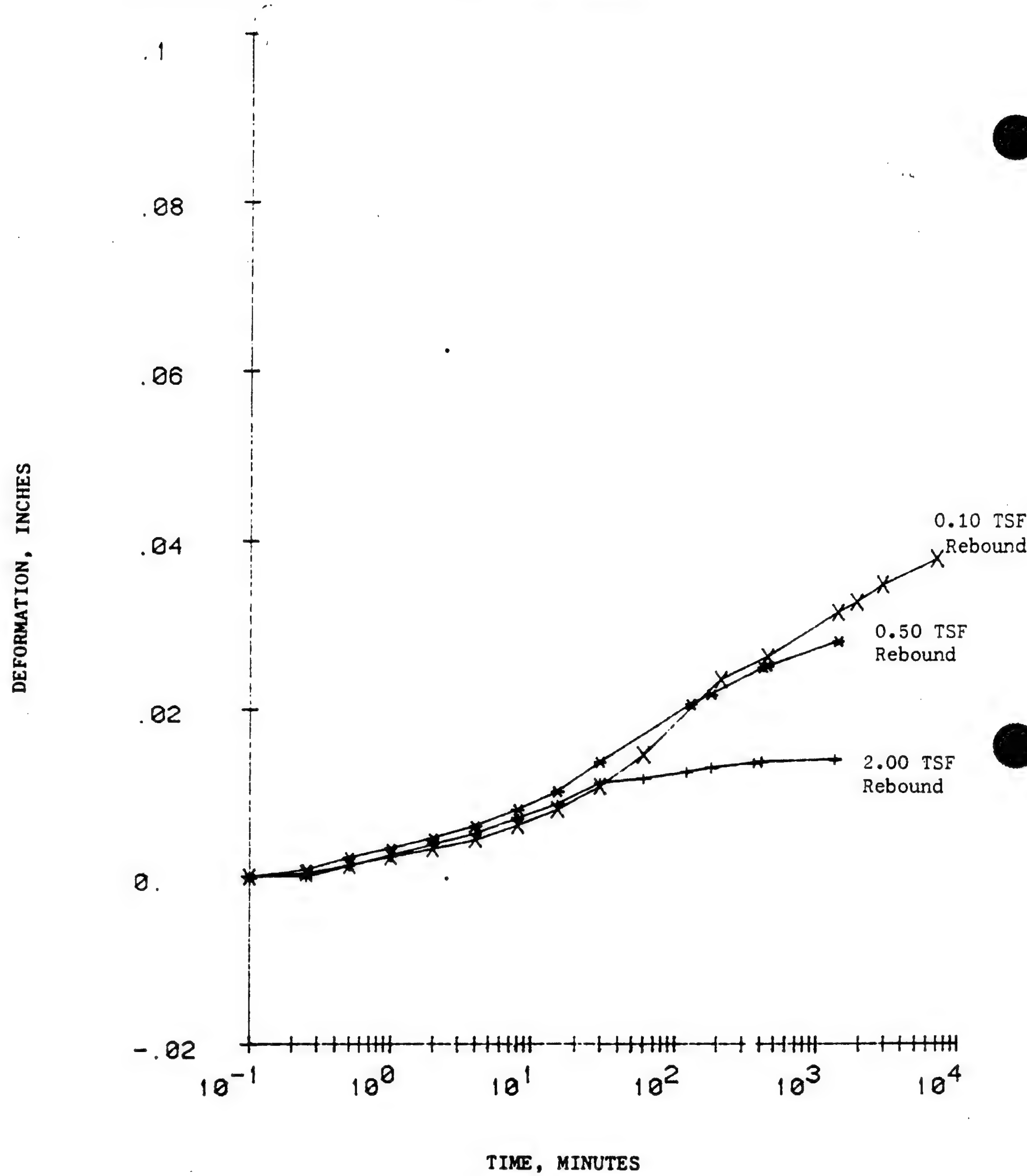
COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 18

Figure C-55

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67

DATE: 17 FEB 1983

BORING NO: 82-41MU SAMPLE NO: 3

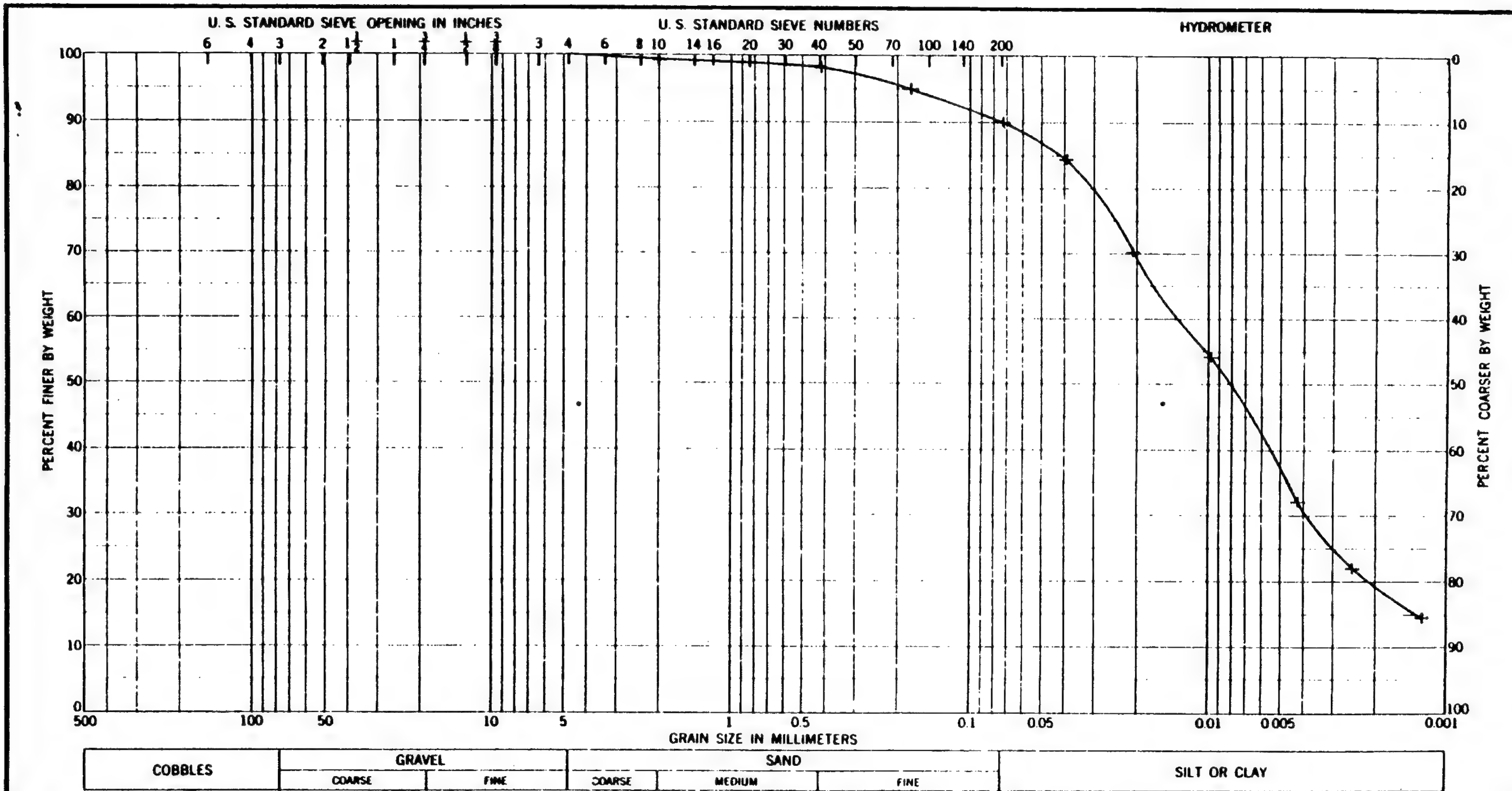
DEPTH/ELEV: 10.0-12.0

CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 19

Figure C-56



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3		Fat clay, CH (Organic)		81	32	49

Project: CHASKA

Area: MRD LAB NO. 83/67

Boring No.: 82-41 MU

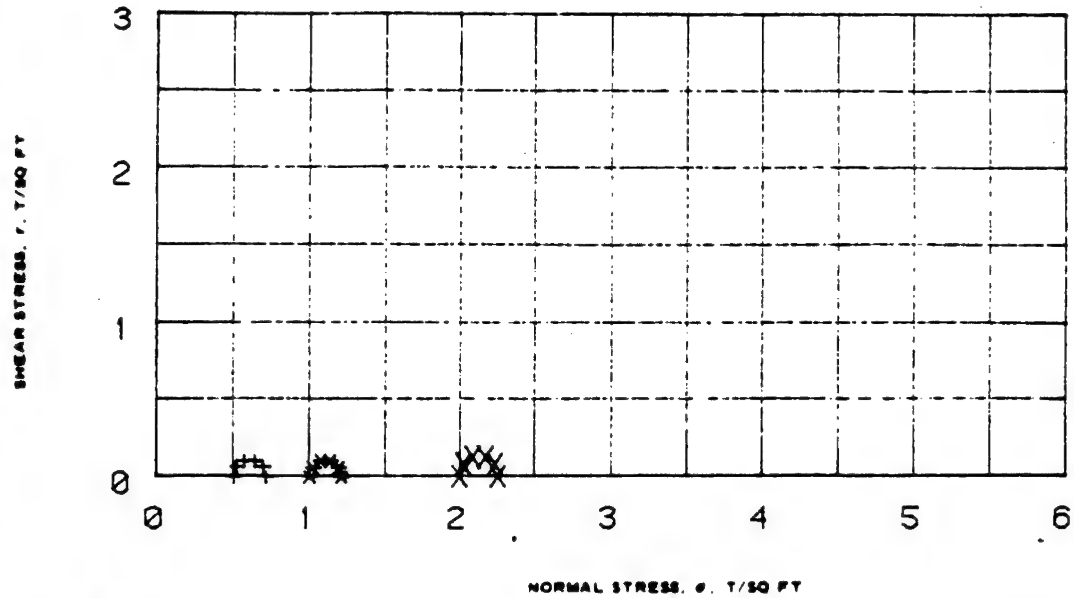
Date: 17 FEB 1983

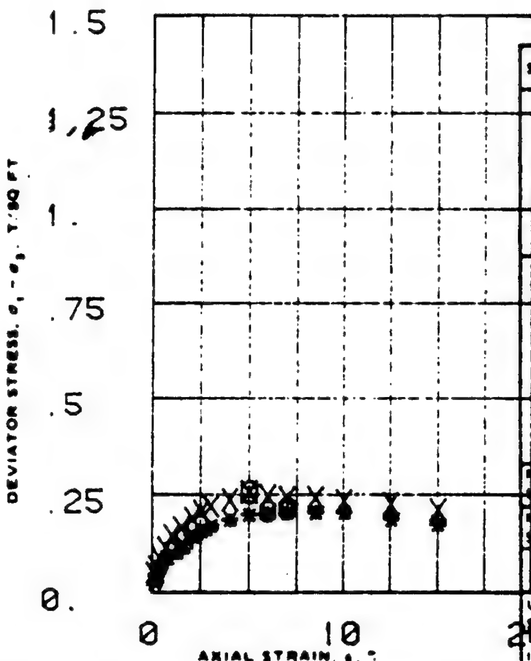
GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 20

Figure C-57





SPECIMEN NO			1	2	
INITIAL	WATER CONTENT, %	w_0	74.	81.1	79.9
	DRY DENSITY LB/CU FT	γ_{d_0}	55.1	52.1	53.
	SATURATION, %	S_0	99.	100.	100.
	VOID RATIO	e_0	1.95	2.11	2.06
BEFORE SHEAR	WATER CONTENT, %	w_c	73.6	80.8	79.8
	DRY DENSITY LB/CU FT	γ_{d_c}	55.1	52.1	53.
	SATURATION, %	S_c	98.	99.	100.
	VOID RATIO	e_c	1.95	2.11	[illegible]
	FINAL BACK PRESSURE, T/SQ FT	u_0	0.	0.	0.
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.216	.209	.259
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	13	12	8
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.177	.170	.213
INITIAL DIAMETER, IN		D_0	1.4	1.38	1.38
INITIAL HEIGHT, IN		H_0	3.00	2.96	2.96

CONTROLLED- TEST

DESCRIPTION OF SPECIMENS Fat clay, CH (Organic)

LL 81	PL 32	PI 49	G_s 2.6	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Dark gray, soft consistency, low strength at PL, no shine, fast shake response, calcareous.

PROJECT CHASKA NCS-IA-82-126-ED-GH

BORING NO 82-41 | SAMPLE NO. 3

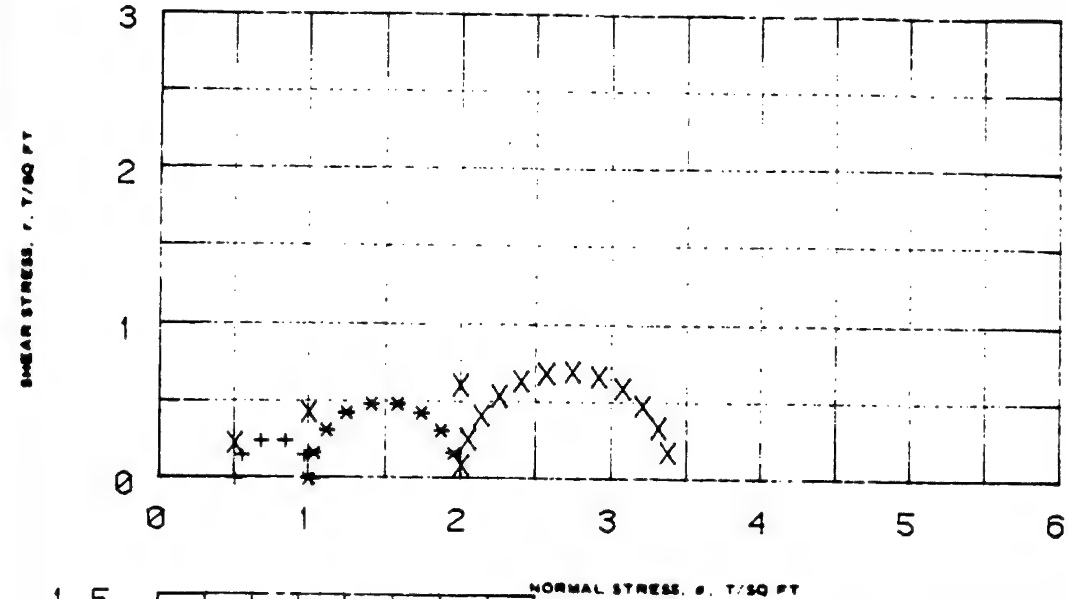
DEPTH ELEV .

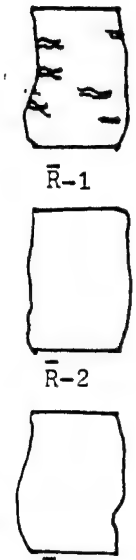
LABORATORY 83/87 | DATE 17 FEB 1983

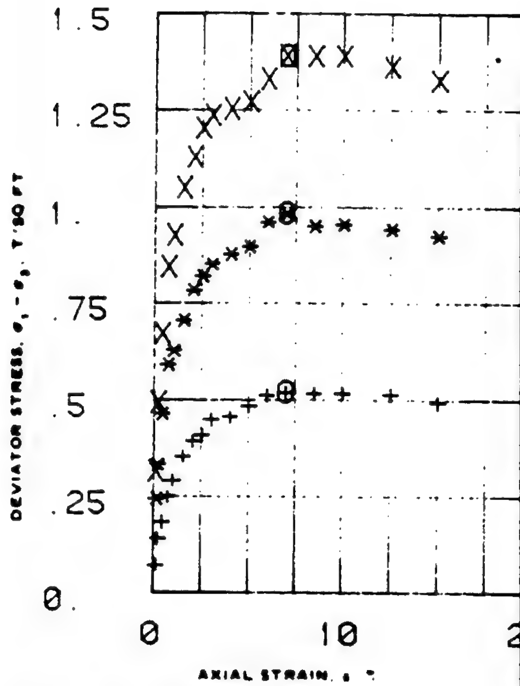
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 11







SPECIMEN NO			1	2	3
INITIAL	WATER CONTENT %	w_o	74.1	65.2	69.7
	DRY DENSITY LB/CU FT	γd_o	55.6	60.2	57.9
	SATURATION, %	S_o	100.	100.	100.
	VOID RATIO	e_o	1.92	1.7	1.81
BEFORE SHEAR	WATER CONTENT, %	w_c	59.8	52.3	47.
	DRY DENSITY LB/CU FT	γd_c	59.6	65.5	71.7
	SATURATION, %	S_c	90.	92.	97.
	VOID RATIO	e_c	1.72	1.48	1.26
	FINAL BACK PRESSURE, T/SQ FT	u_o	1.9	1.9	1.9
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.
MAXIMUM DEVIATOR STRESS T/SQ FT	$(\sigma_1 - \sigma_3)_{max}$		.521	.987	1.39
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	530	530	510
ULTIMATE DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{ult}$		.498	.929	1.33
INITIAL DIAMETER, IN		D_o	1.4	1.4	1.4
INITIAL HEIGHT, IN		H_o	2.97	3.	2.99

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH (Organic)

LL 81 | PL 32 | PI 49 | Gs 2.6 | TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST R̄

REMARKS The relatively low strength of R̄-3 is due to material change (organic lens) in the sample.

PROJECT CHASKA NCS-IA-82-126-ED-GH

BORING NO 41 | SAMPLE NO 3

DEPTH ELEV .

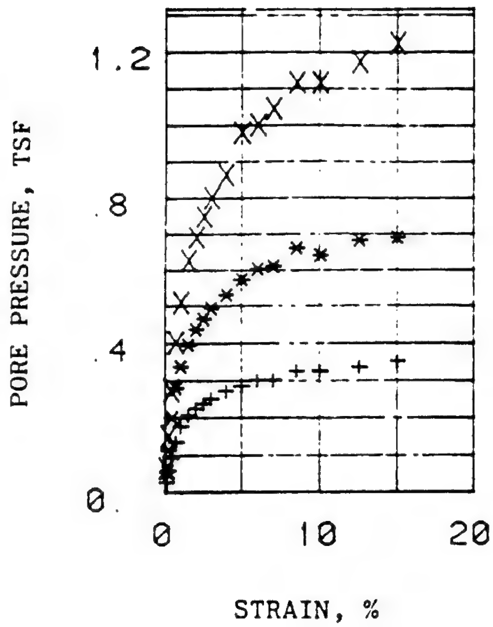
B value = 1.00

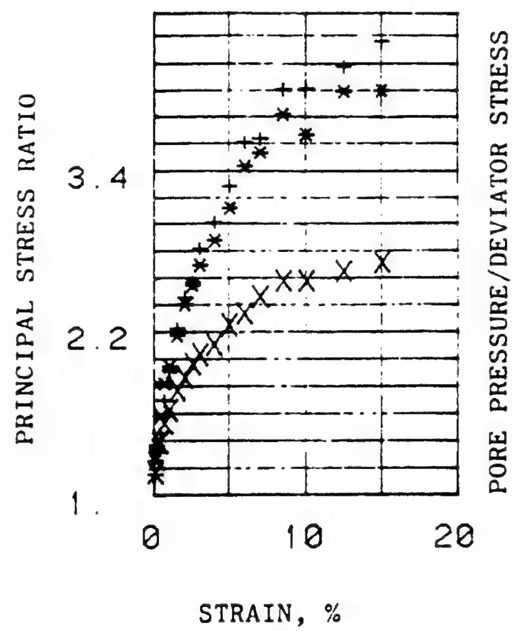
LABORATORY 83/87 | DATE 17 FEB 1983

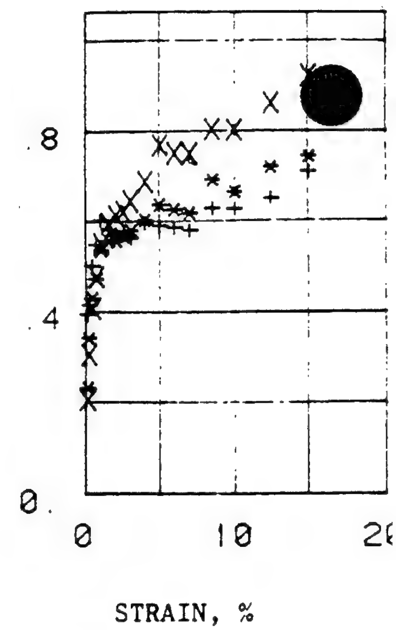
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

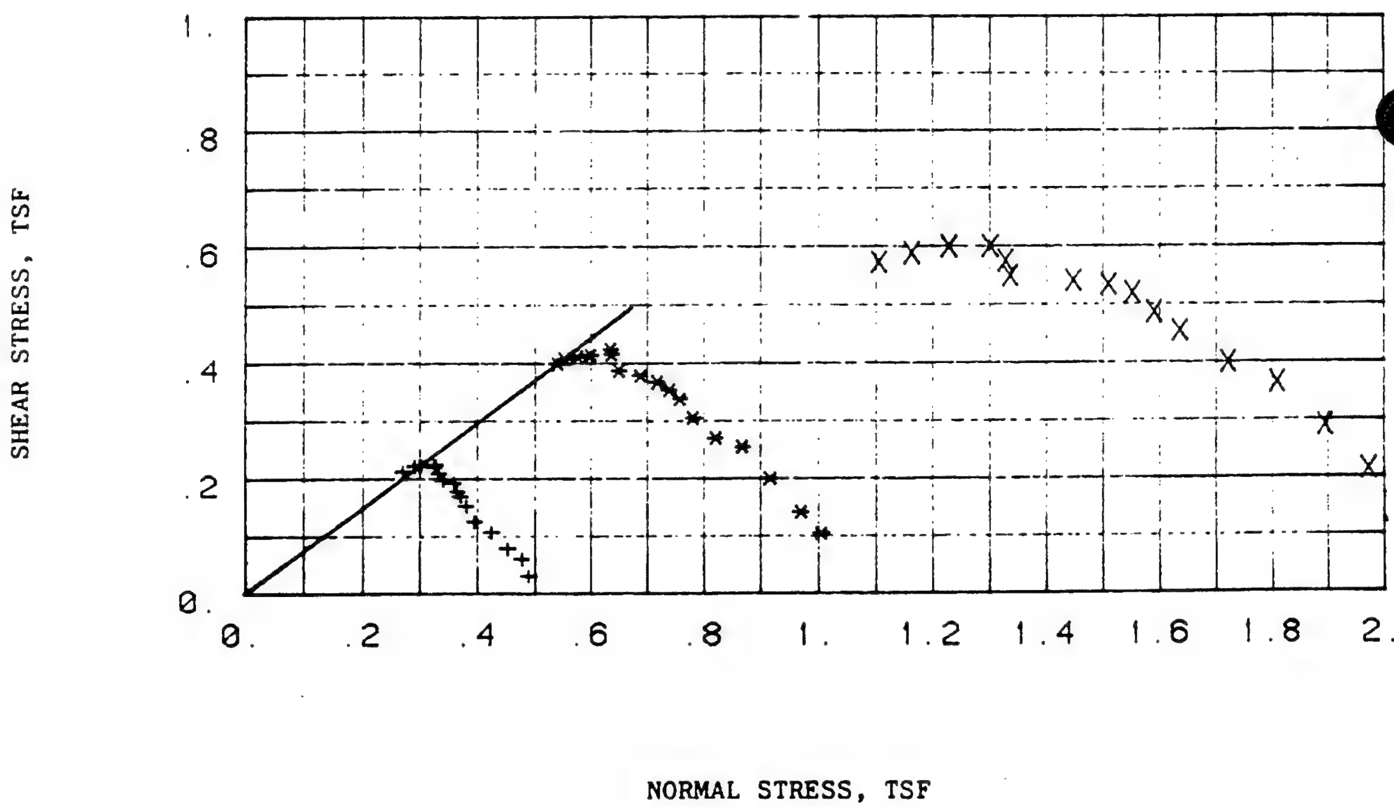
Figure 12







EFFECTIVE STRESS VECTOR CURVES ON 60.DEGREE PLANE



REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

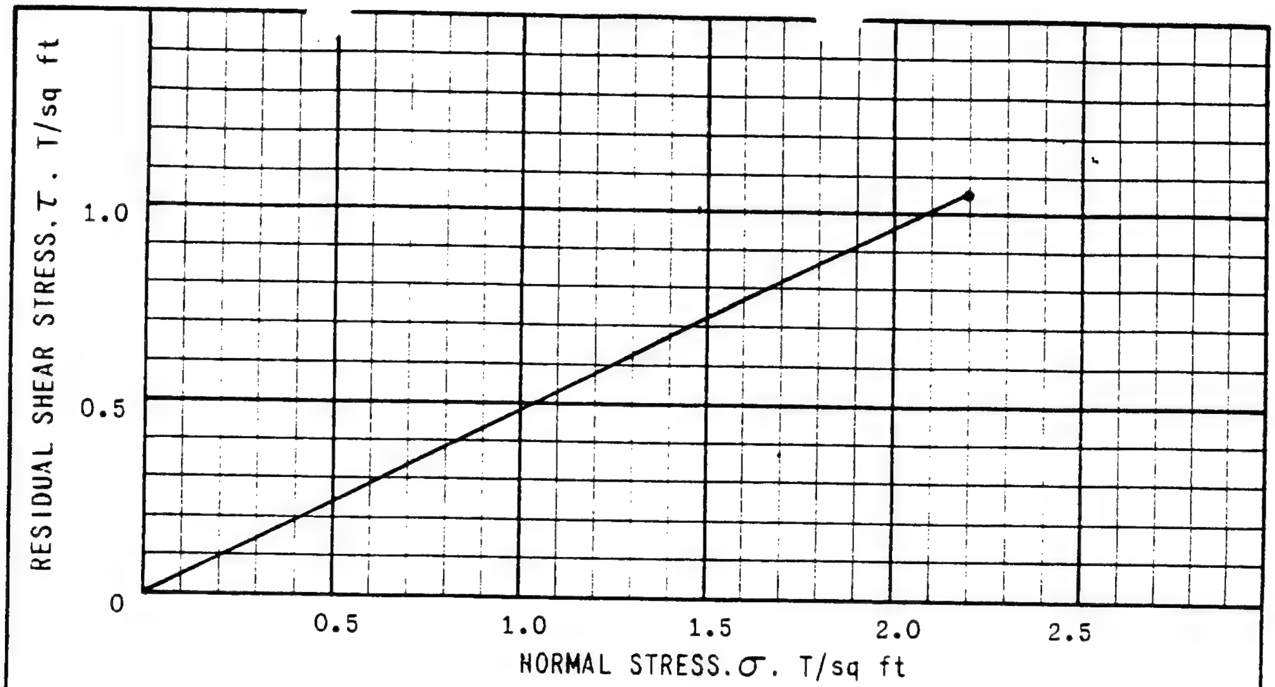
PROJECT:	CHASKA NCS-IA-82-126-ED-GH		
BORING NO:	41	SAMPLE NO:	3
DEPTH/ELEV:	.		
MRD LAB NO:	83/87	DATE:	17 FEB 1983

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 13

MRD Form 756, 1 May 80

Figure C-



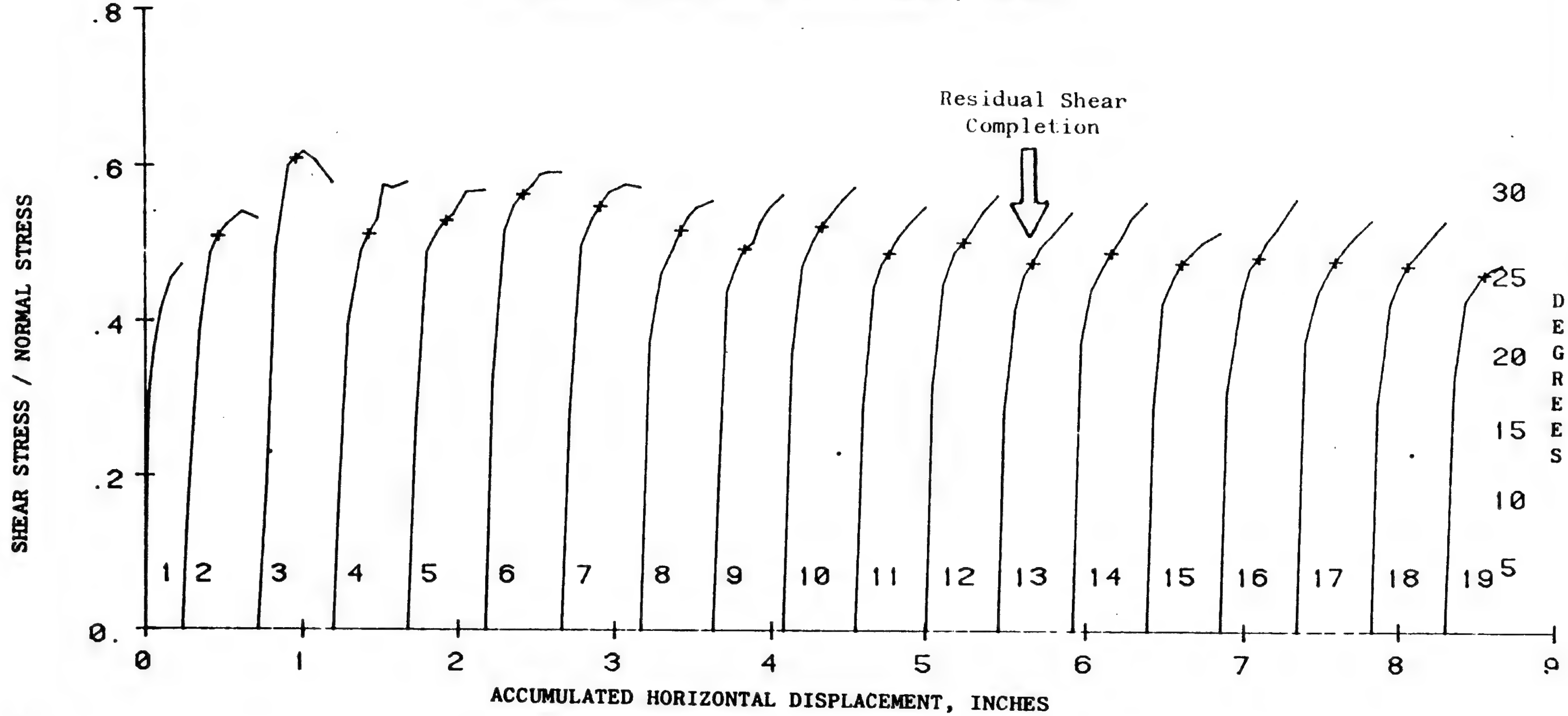
TEST NO.		1		
INITIAL: WATER CONTENT	w_o	65.5		
INITIAL: VOID RATIO	e_o	1.69		
INITIAL: SATURATION	S_o	100.0		
INITIAL: DRY DENSITY, lb/cu ft	γ_d	51.8		
SPECIFIC GRAVITY	G_s	2.60		
LIQUID LIMIT	LL	81		
PLASTIC LIMIT	PL	32		
WATER CONTENT	w_f	40.0		
NORMAL STRESS, T/sq ft	σ	2.2		
MAXIMUM SHEAR STRESS, T/sq ft	τ_{max}	–		
DISPLACEMENT TO MAXIMUM, inches		–		

RESIDUAL SHEAR STRESS, T/sq ft		1.06		
τ/σ AT RESIDUAL		0.48		
TIME TO RESIDUAL, days		18.2		
DISPLACEMENT TO RESIDUAL, inches		5.67		
FINAL SHEAR STRESS, T/sq ft		1.03		
FINAL DISPLACEMENT, inches		8.5		
LENGTH OF TEST, days		26.6		
MATERIAL EXTRUDED, gms		5.0		
MATERIAL EXTRUDED,		3.6		
SHEAR STRENGTH PARAMETERS	ϕ MAXIMUM	–		
	ϕ RESIDUAL	25.6°*		
	COHESION T/sq ft	0		

SPECIMEN DIMENSIONS 3.0 IN. SQUARE 0.5 IN. THICK	MISSOURI RIVER DIVISION LABORATORY OMAHA, NEBRASKA
CONTROLLED ☒ STRAIN ☐ STRESS	PROJECT Chaska LAB. NO. 83/67
TYPE OF SPECIMEN Undisturbed, precut	AREA
CLASSIFICATION Fat clay, CH (Organic)	BORING NO. 82-41 SAMPLE NO. 3
*The residual shear test is normally used on hard shales and these results may not be meaningful.	DEPTH/ELEVATION 10.0-12.0 DATE 17 FEB 1983
	RESIDUAL DIRECT SHEAR TEST REPORT

MRD FORM 1 NOV 68 769

SHEAR STRESS/NORMAL STRESS
VS.
ACCUMULATED HORIZONTAL DISPLACEMENT, INCHES



PULL NO:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
IN./DAY:	.23	.51	.15	.49	.5	.52	.52	.15	.46	.47	.46	.45	.16	.47	.49	.48	.48	.16	.55

SPECIMEN TYPE: UNDISTURBED, PRECUT

NORMAL STRESS, T/SF: 2.2

REMARKS: —

PROJECT: CHASKA

BORING NO: 82-41 SAMPLE NO: 3

DEPTH: 10.0-12.0

MRD LAB NO: 83/87 DATE: 17 FEB 1983

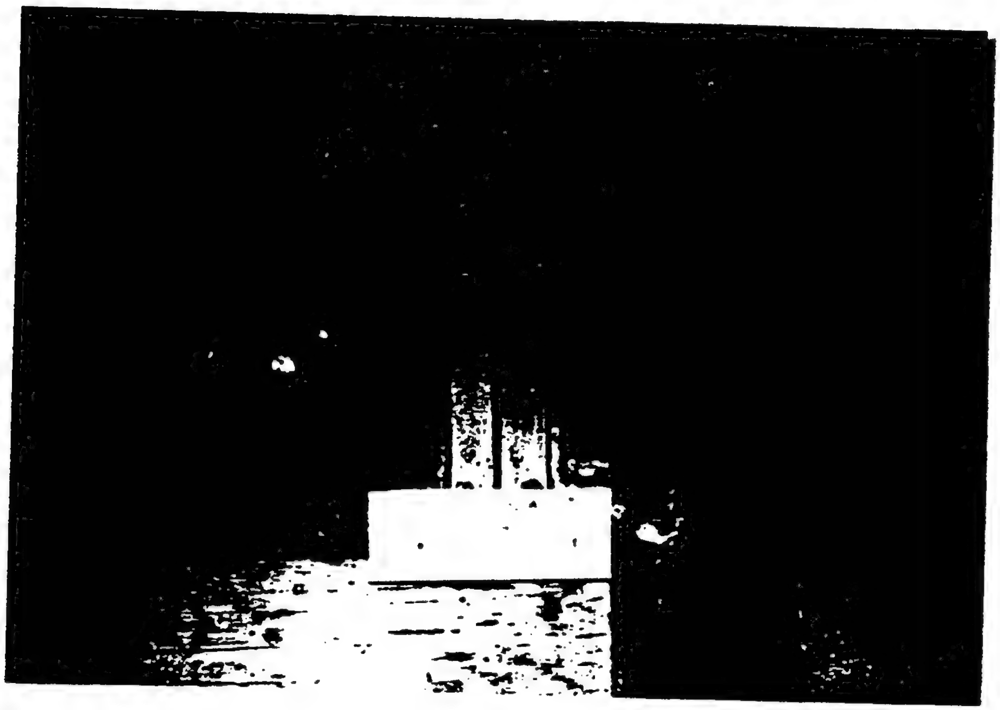
RESIDUAL DIRECT SHEAR TEST REPORT

FIGURE: 15

MRD Fo 769, 1 May 80 (Replaces 1 Nov 68 edition)

Figure C-62

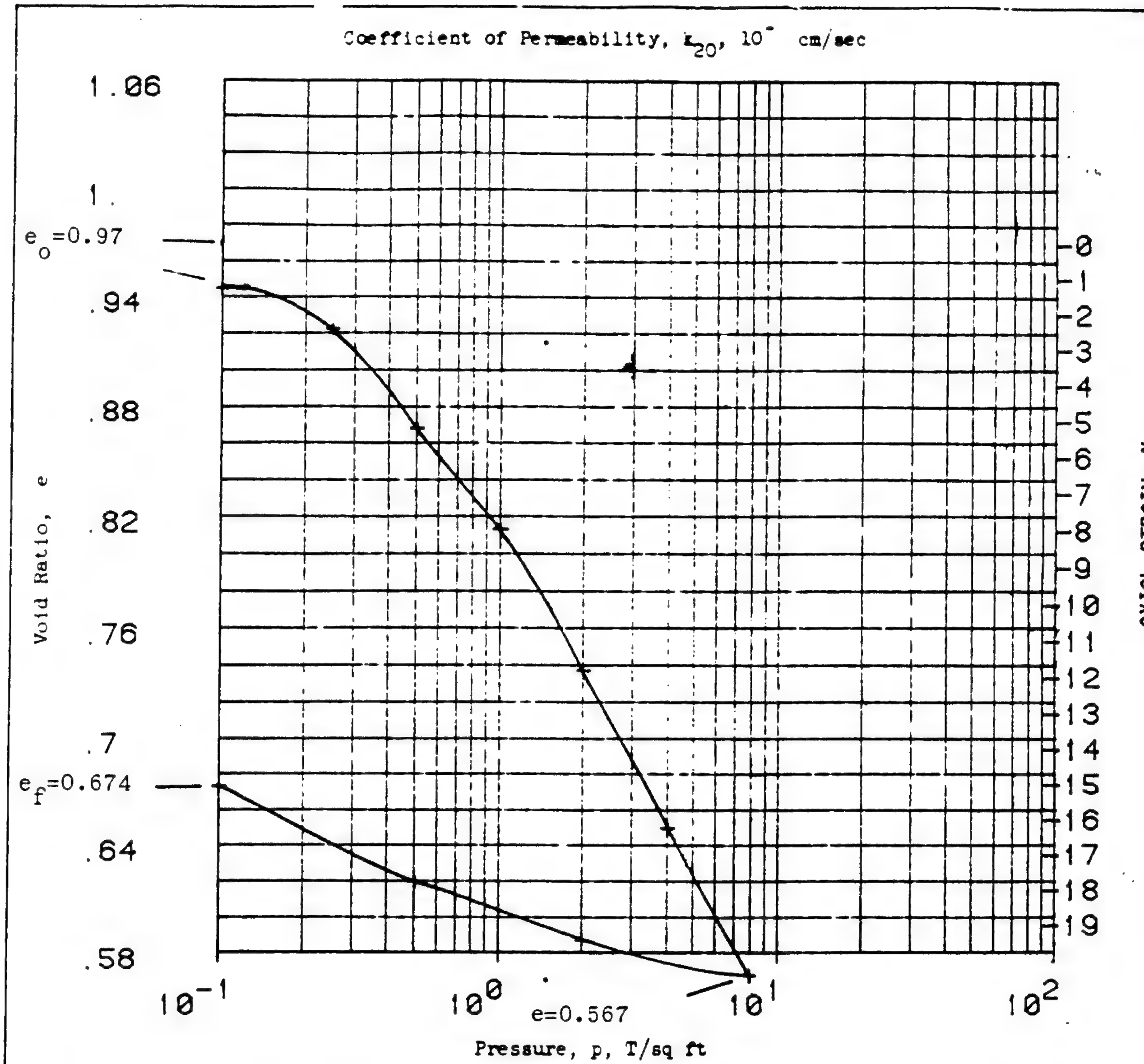
DEPARTMENT OF THE ARMY
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska



Residual Shear Test Boring 83-41 Sample 3

Plate 1

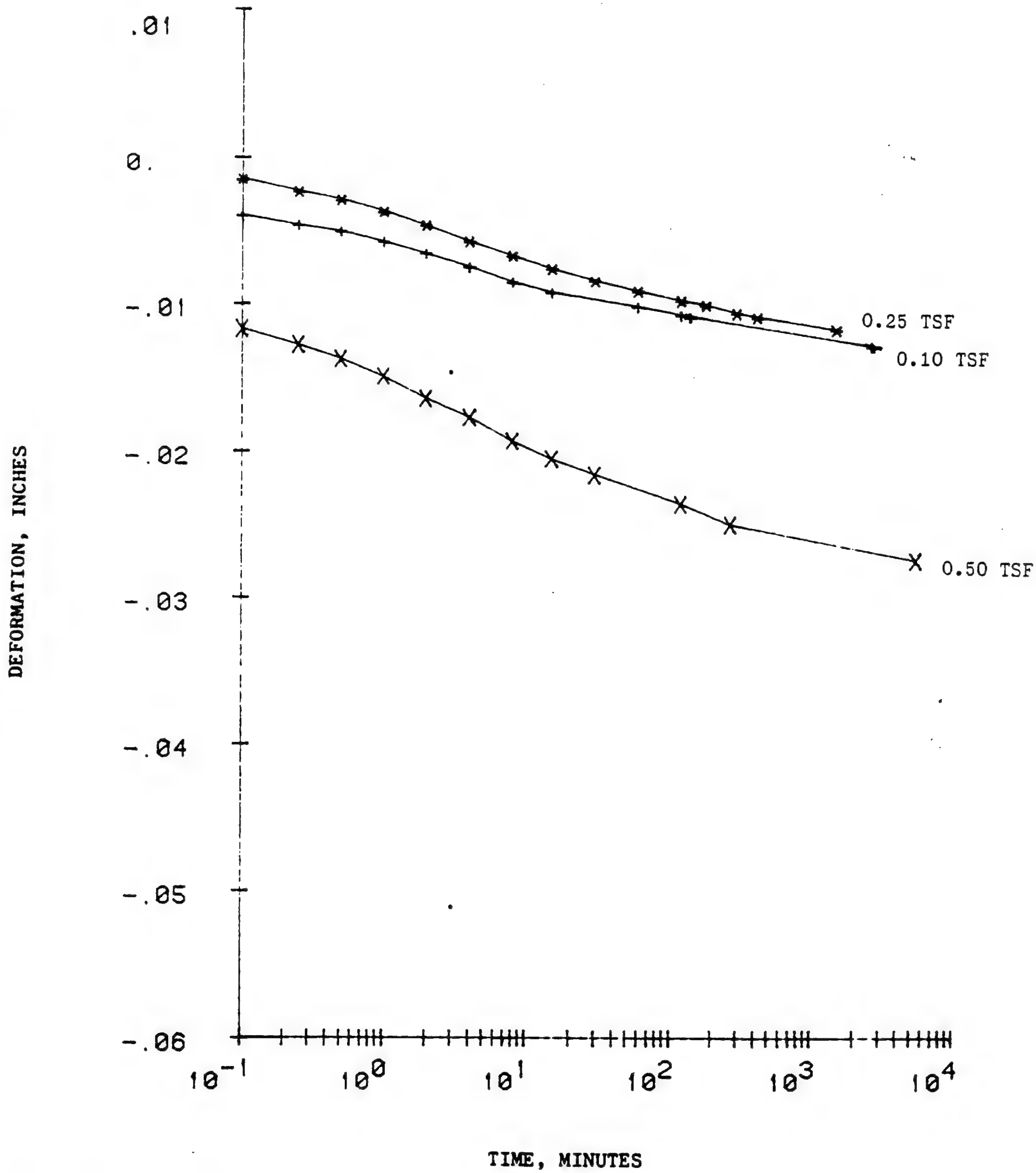
Figure C-63



Type of Specimen UNDISTURBED		Before Test		After Test
Diam 4.3 in.	Ht .999 in.	Water Content, w_o	34.8 %	w_f 26.6 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	.97	e_f .67
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	96. %	S_f 100. %
Compression Index, C_c		Dry Density, γ_d	84.6 lb/ft^3	
Classification Sandy clay, CH		k_{20} at e_o = × 10^{-} cm/sec		
LL 56	G_s 2.67	Project CHASKA NCS-IA-82-126-ED-GH		
PL 19	D_{10}			
Remarks Note the high secondary consolidation.		Area MRD LAB NO: 83/67		
		Boring No. 82-41MU		Sample No. 4
		Depth El 18.0-19.2		Date 17 FEB 1983
		CONSOLIDATION TEST REPORT		

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 26 Figure C-64



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67

DATE: 17 FEB 1983

BORING NO: 82-41MU

SAMPLE NO: 4

DEPTH/ELEV: 18.8-19.2

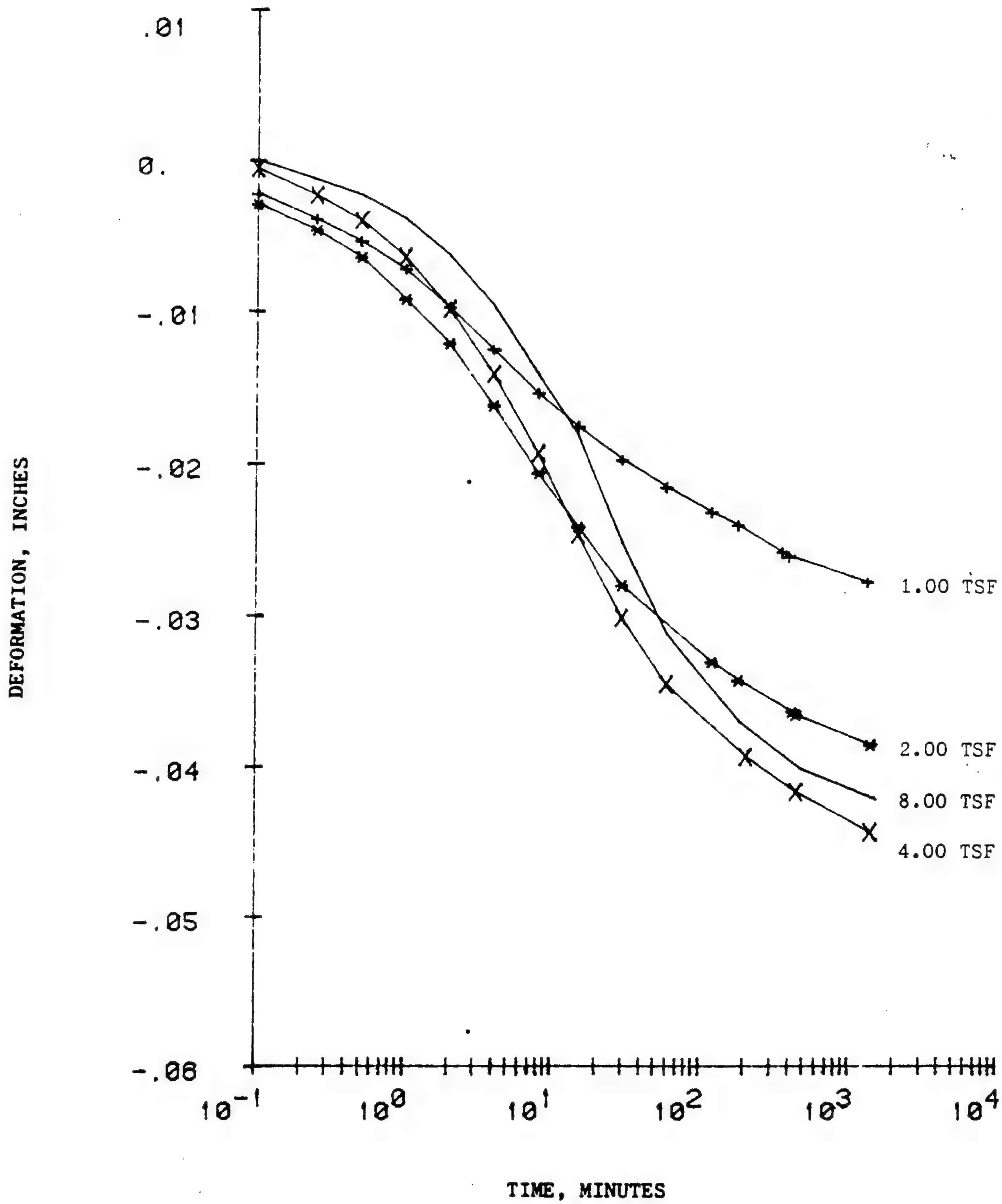
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 27

Figure C-65

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67

DATE: 17 FEB 1983

BORING NO: 82-41MU SAMPLE NO: 4

DEPTH/ELEV: 18.8-19.2

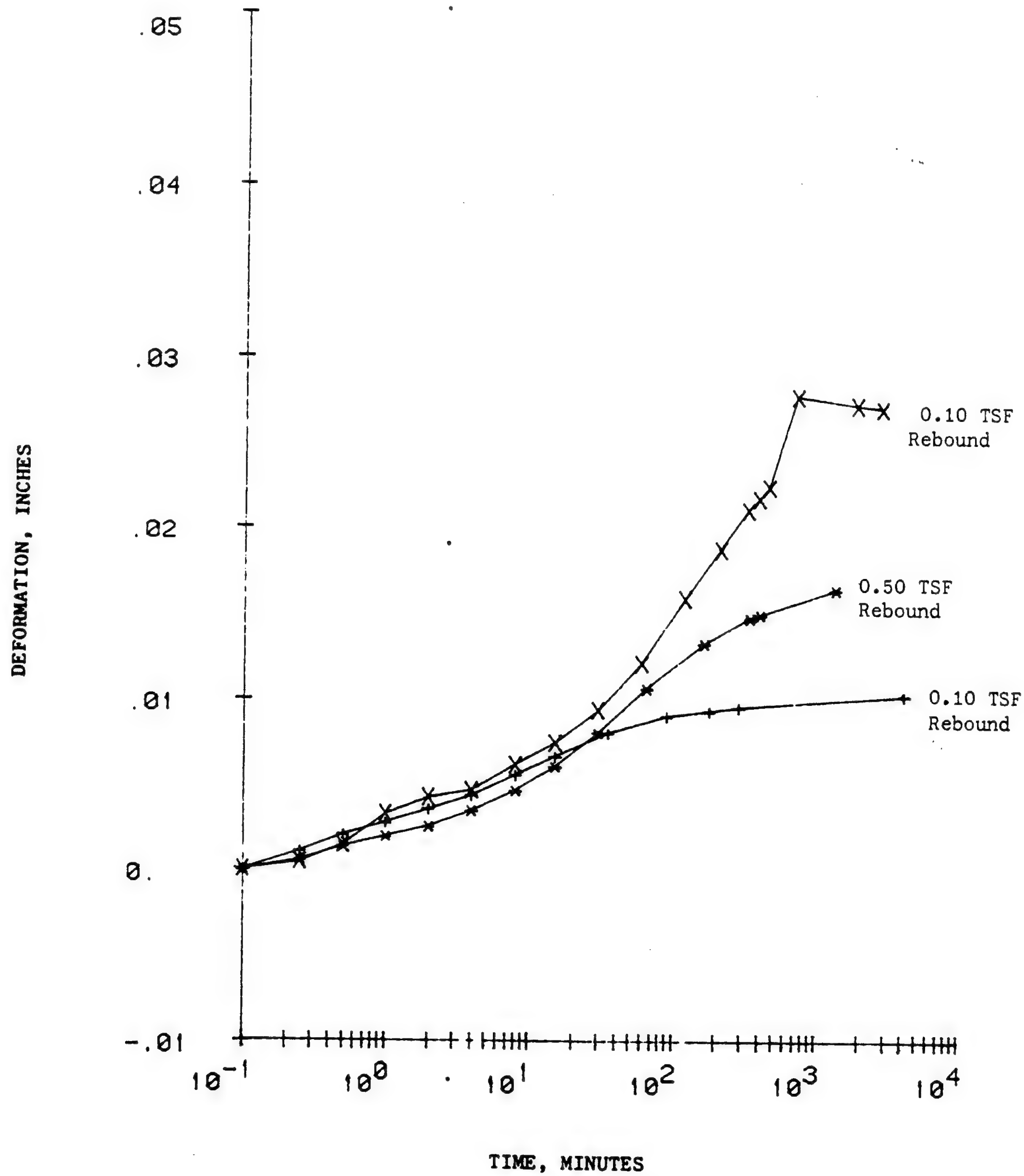
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 28

Figure C-66

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67 DATE: 17 FEB 1983

BORING NO: 82-41MU SAMPLE NO: 4 DEPTH/ELEV: 18.0-19.2

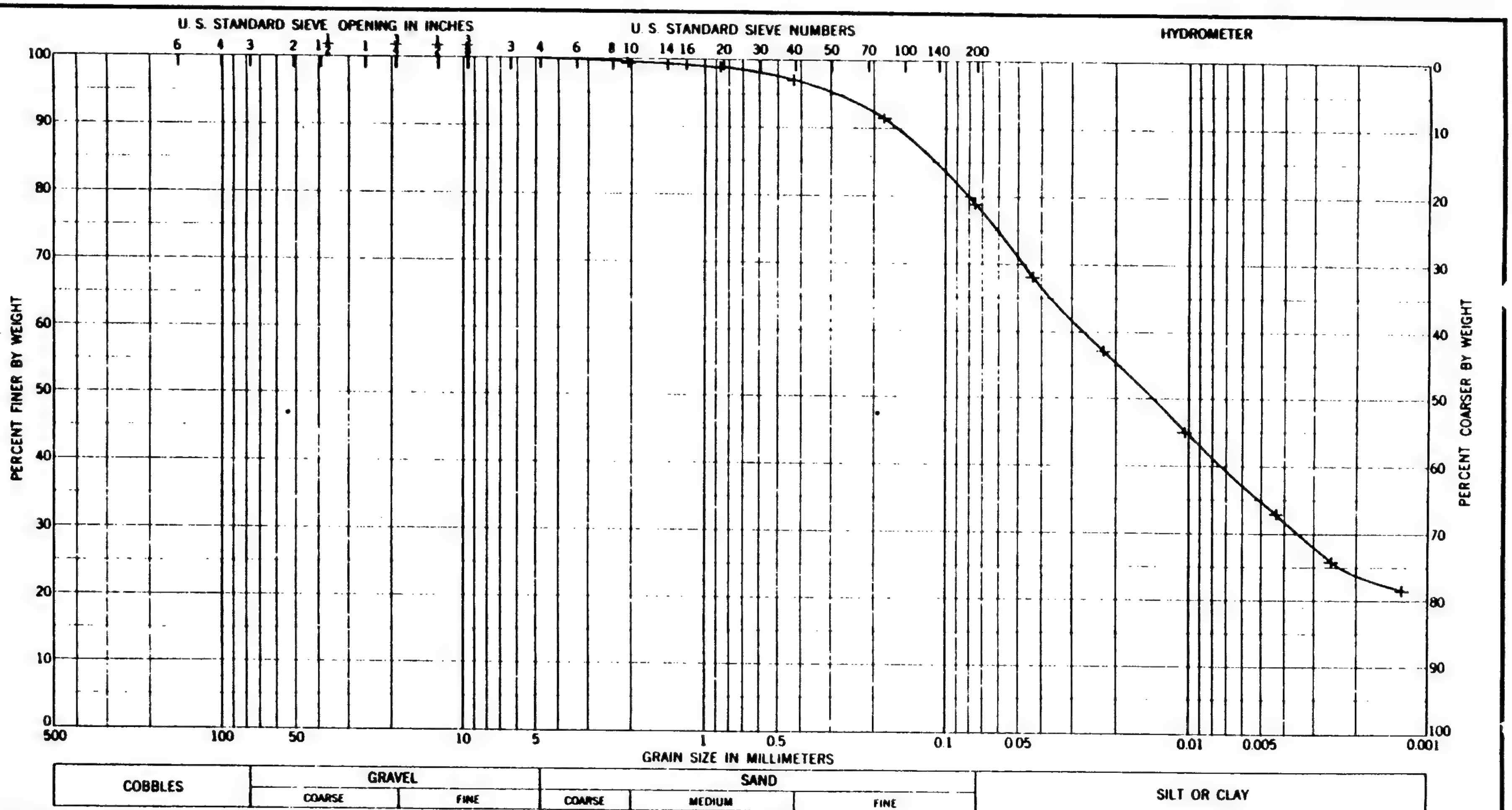
COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 29

Figure C-67

MRD Form 956, 1 May 80



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	.	Sandy clay, CH		56	19	37

Project CHASKA .

Area MRD LAB NO. 83/67

Boring No. 82-41 MU

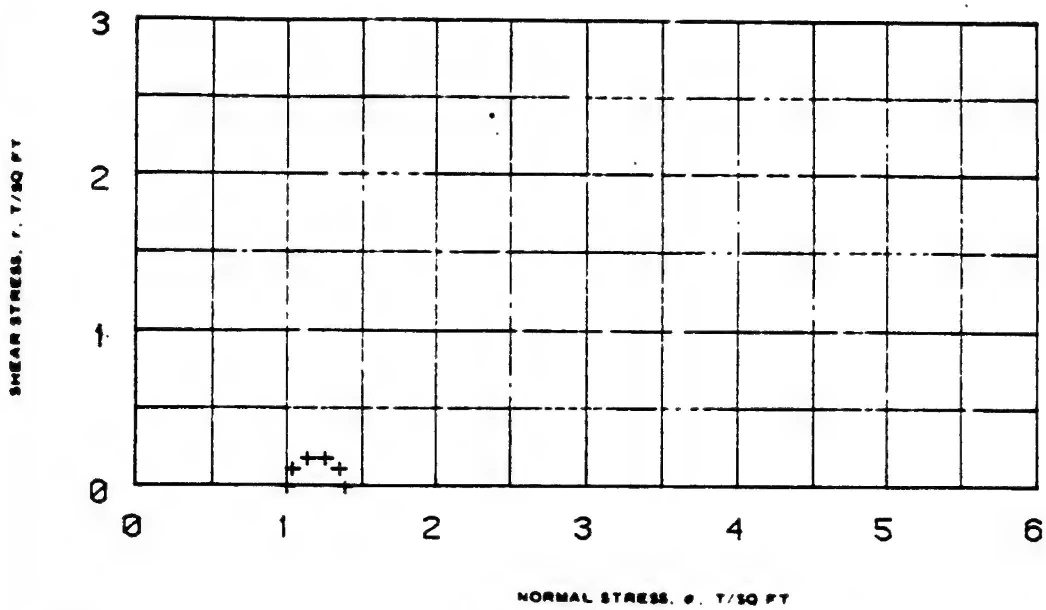
Date 17 FEB 1983

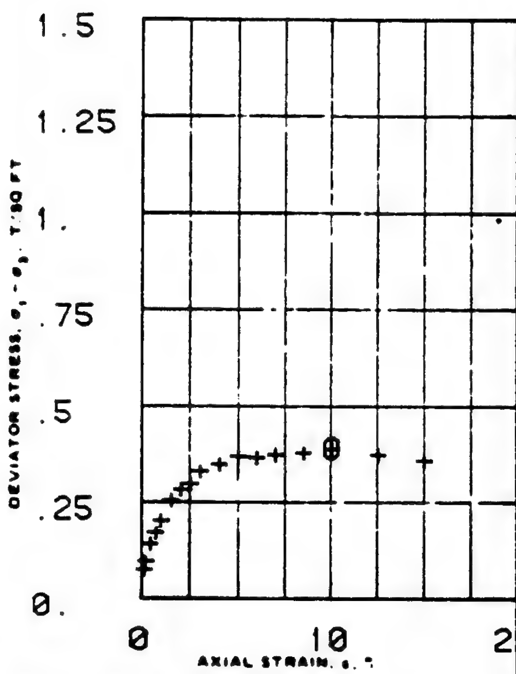
GRADATION CURVES

ENG FORM 2087

FIGURE

Figure C-68





SPECIMEN NO.			1			
INITIAL	WATER CONTENT, %	w_0	30.3			
	DRY DENSITY LB/CU FT	γ_{d_0}	72.7			
	SATURATION, %	S_0	65.			
	VOID RATIO	e_0	1.29			
BEFORE SHEAR	WATER CONTENT, %	w_c	30.1			
	DRY DENSITY LB/CU FT	γ_{d_c}	72.7			
	SATURATION, %	S_c	82.			
	VOID RATIO	e_c	1.29			
	FINAL BACK PRESSURE, T/SQ FT	u_0	0.			
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.			
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.309			
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	21			
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.30			
INITIAL DIAMETER, IN		D_0	1.57			
INITIAL HEIGHT, IN		H_0	3.00			

CONTROLLED- TEST

DESCRIPTION OF SPECIMENS Sandy clay, CH

LL 56	PL 19	PI 37	G_s 2.67	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Dark gray-black, soft consistency, low strength at PL, no shine, fast shake response. There was only enough material to run one Q specimen and it may have been disturbed during sampling.

PROJECT CHASKA NCS-JA-82-128-ED-GH

BORING NO 82-41 SAMPLE NO. 3

DEPTH ELEV 18.8-19.2

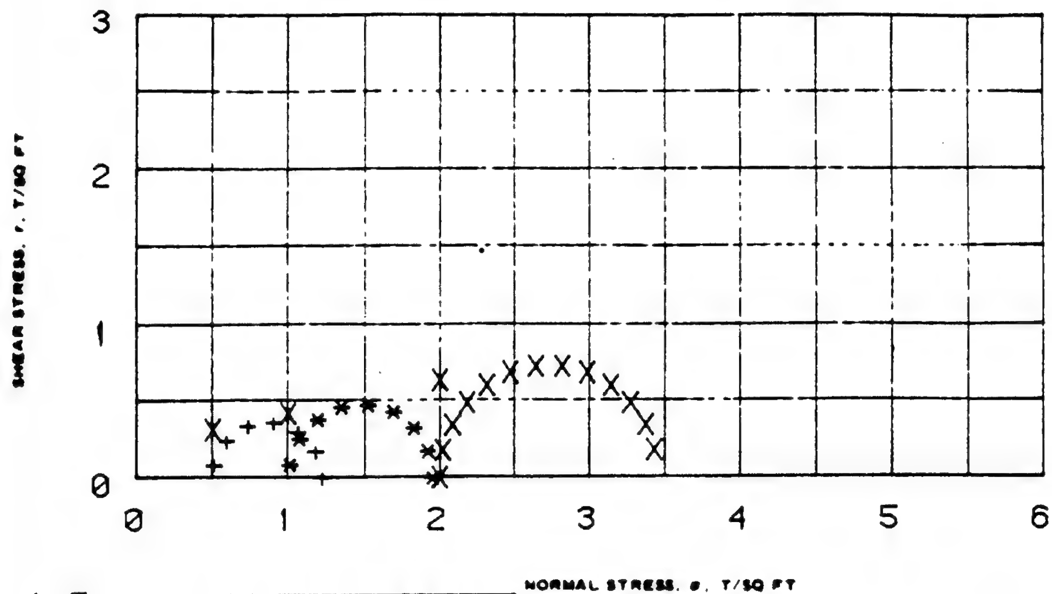
LABORATORY 85/87 DATE 17 FEB 1983

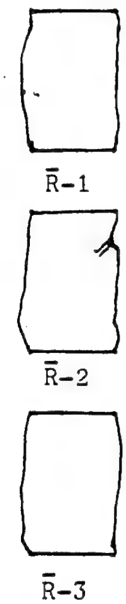
TRIAXIAL COMPRESSION TEST REPORT

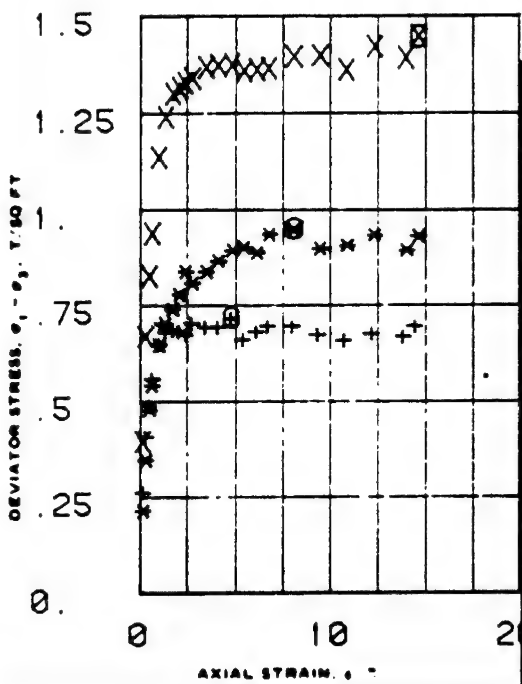
ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

Figure 21

Figure C-69







			1	2	3
SPECIMEN NO			1	2	3
INITIAL	WATER CONTENT, %	w_o	38.7	35.9	38.9
	DRY DENSITY LB/CU FT	γ_{d_o}	91.	86.4	92.1
	SATURATION, %	S_o	99.	100.	100.
	VOID RATIO	e_o	.85	.95	.81
BEFORE SHEAR	WATER CONTENT, %	w_c	30.1	30.	25.7
	DRY DENSITY LB/CU FT	γ_{d_c}	92.4	90.4	97.6
	SATURATION, %	S_c	100.	95.	97.
	VOID RATIO	e_c	.8	.84	.71
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.1	4.1	4.1
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.72	.962	1.45
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	195	255	338
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.882	.890	1.45
INITIAL DIAMETER, IN.		D_o	1.41	1.4	1.41
INITIAL HEIGHT, IN.		H_o	3.	2.98	3.

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CH

LL 56 | PL 19 | PI 37 | G_s 2.67

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST R̄

REMARKS: The fluctuations in pore pressures and confining pressures may be due to ambient temperature change during the test.

B value = 1.00

PROJECT CHASKA

BORING NO 82-41 | SAMPLE NO 4

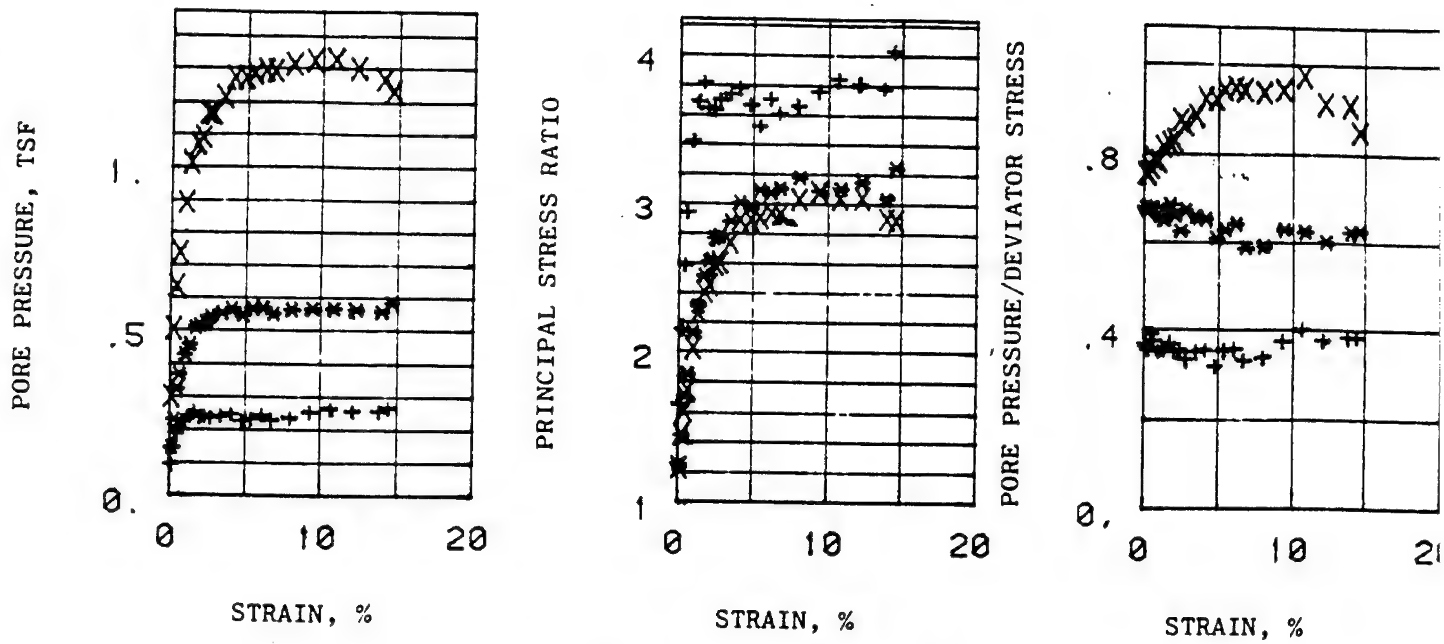
DEPTH ELEV

LABORATORY 85/87 | DATE 17 FEB 1983

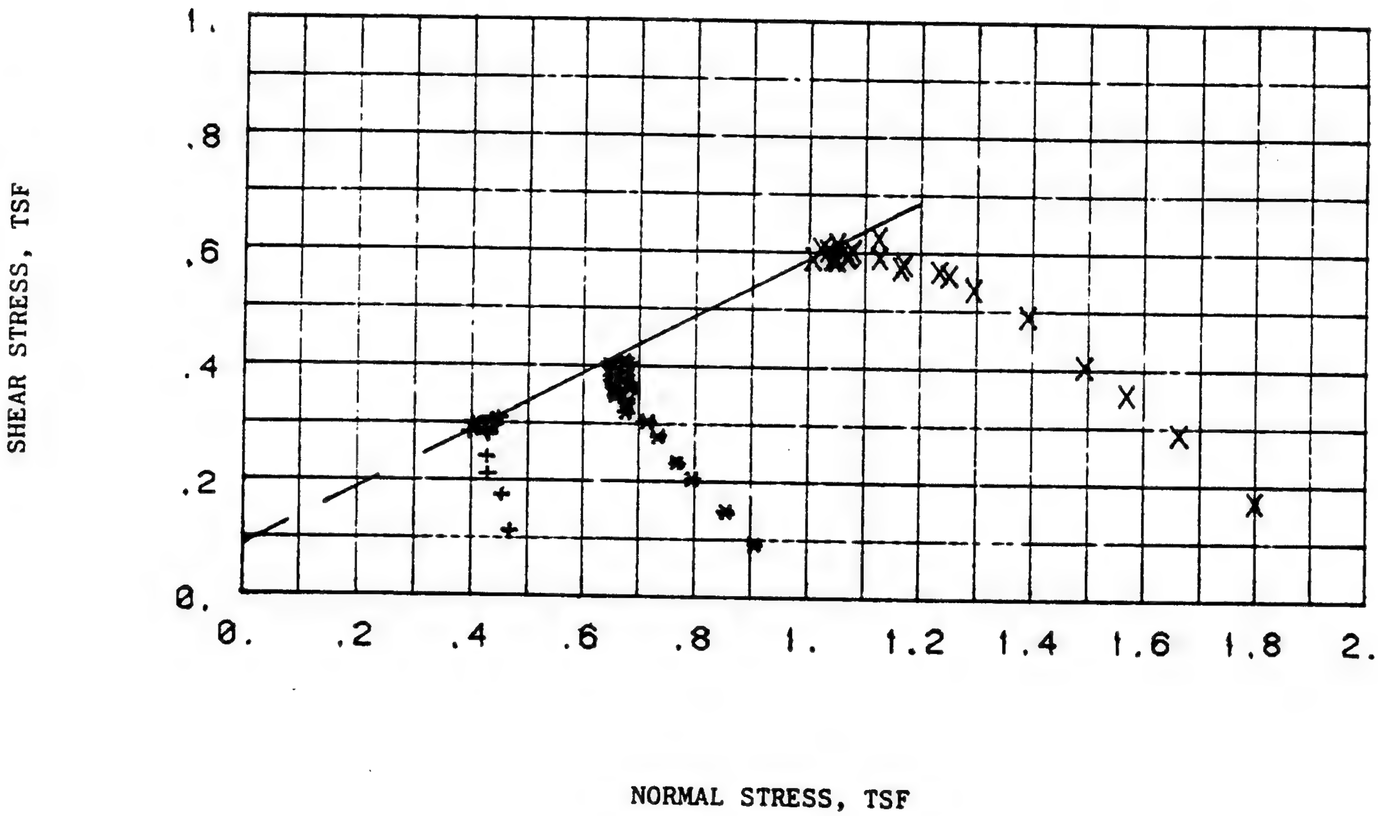
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 22



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



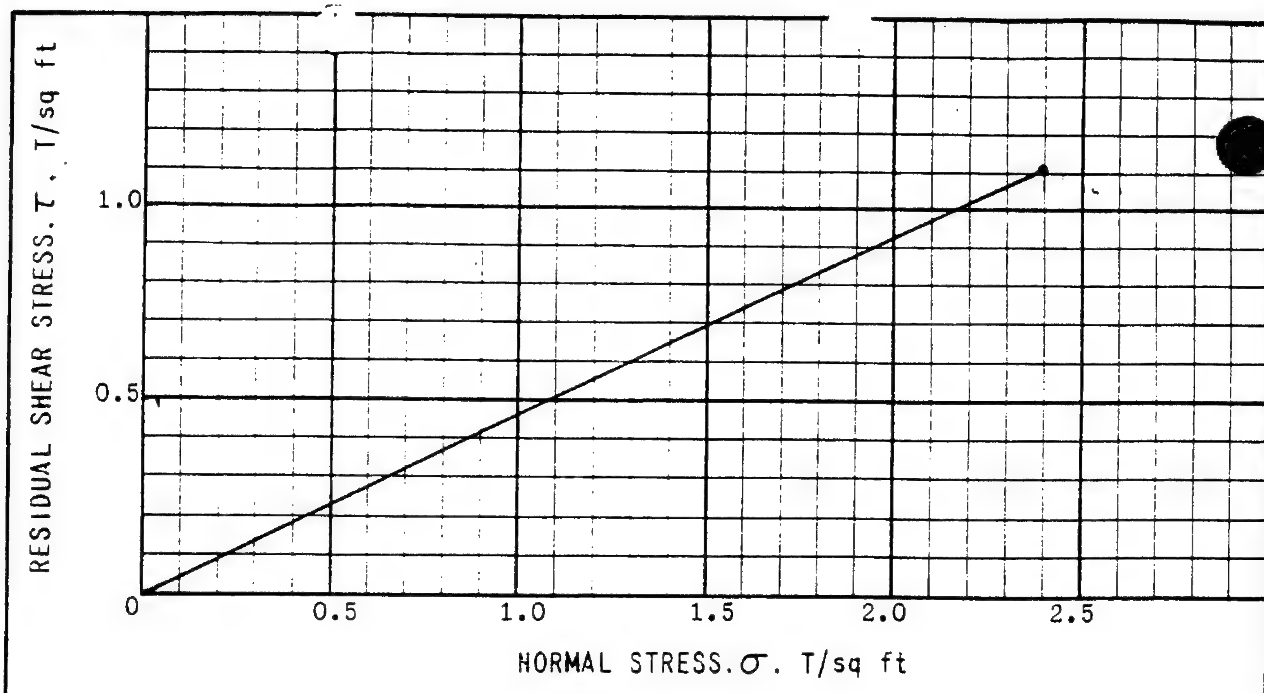
REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
$\bar{R}$ TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

PROJECT: CHASKA
BORING NO: 82-41
DEPTH/ELEV:
MRD LAB NO: 83/87
SAMPLE NO: 4
DATE: 17 FEB 1983

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 23

MRD Form 756, 1 May 80



TEST NO.			1			RESIDUAL SHEAR STRESS. T/sq ft	1.11		
INITIAL	WATER CONTENT	w_o	35.4			τ/σ AT RESIDUAL	0.46		
	VOID RATIO	e_o	0.97			TIME TO RESIDUAL. days	5.9		
	SATURATION	S_o	97.5			DISPLACEMENT TO RESIDUAL. inches	1.46		
	DRY DENSITY. lb/cu ft	d	84.6			FINAL SHEAR STRESS. T/sq ft	1.23		
SPECIFIC GRAVITY		G_s	2.67			FINAL DISPLACEMENT. inches	6.78		
LIQUID LIMIT		LL	56			LENGTH OF TEST. days	20.7		
PLASTIC LIMIT		PL	19			MATERIAL EXTRUDED. gms	2.7		
WATER CONTENT		w_f	25.1			MATERIAL EXTRUDED.	1.4		
NORMAL STRESS. T/sq ft		σ	2.4			SHEAR STRENGTH PARAMETERS — Φ MAXIMUM	–		
MAXIMUM SHEAR STRESS. T/sq ft		$\tau_{max.}$	–			SHEAR STRENGTH PARAMETERS — Φ RESIDUAL	24.7*		
DISPLACEMENT TO MAXIMUM. inches			–			SHEAR STRENGTH PARAMETERS — COHESION T/sq ft	0		

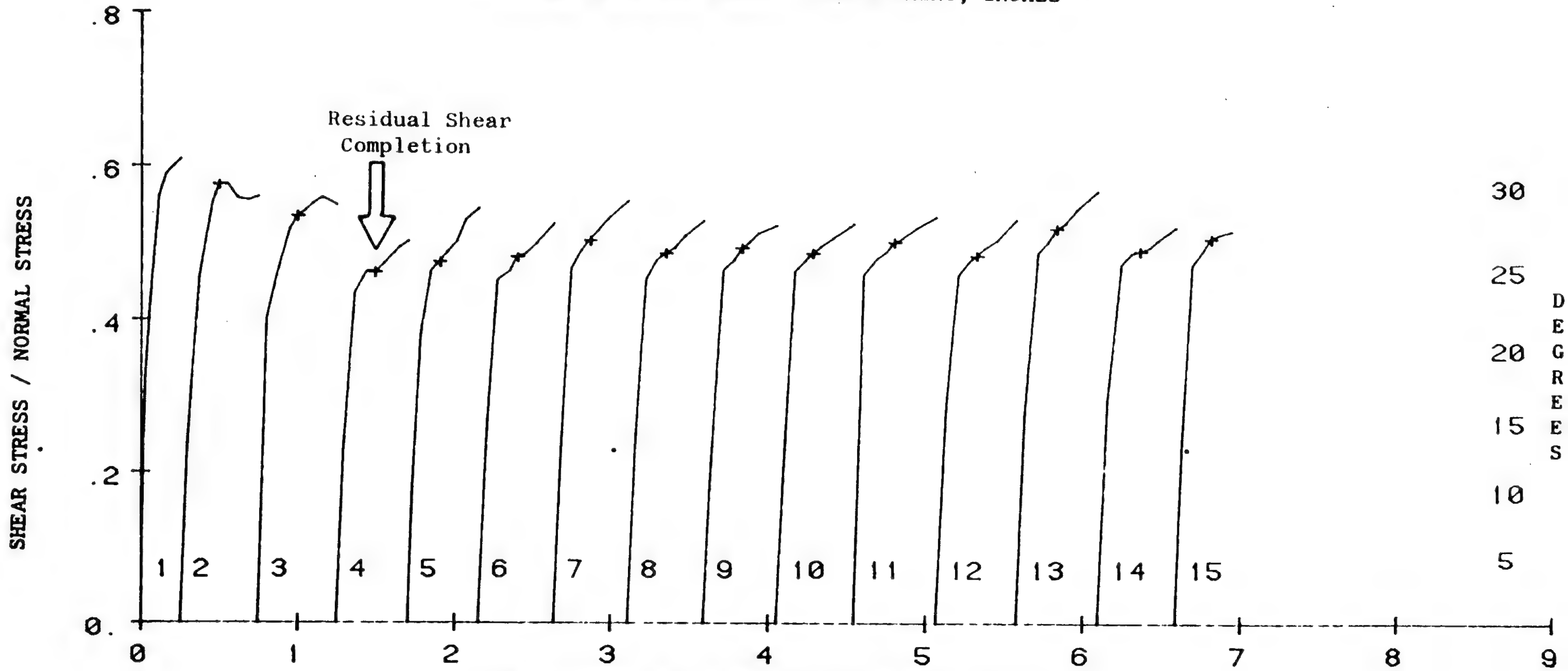
SPECIMEN DIMENSIONS 3.0 IN. SQUARE 0.5 IN. THICK	MISSOURI RIVER DIVISION LABORATORY. OMAHA. NEBRASKA
CONTROLLED ☒ STRAIN ☐ STRESS	PROJECT Chaska LAB. NO. 83/67
TYPE OF SPECIMEN Undisturbed, precut	AREA
CLASSIFICATION Sandy clay, CH	BORING NO. ~~83~~ 53-41 SAMPLE NO. 4
*The residual shear test is normally used on hard shales and	DEPTH ELEVATION DATE 17 FEB 1983
may not be meaningful on this material.	RESIDUAL DIRECT SHEAR TEST REPORT

MRD FORM 1 NOV 68 769

Figure 24

Figure C-72

SHEAR STRESS/NORMAL STRESS
VS.
ACCUMULATED HORIZONTAL DISPLACEMENT, INCHES



PULL NO:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
IN./DAY:	.27	.49	.43	.15	.47	.46	.47	.54	.16	.53	.56	.52	.52	.17	.42

SPECIMEN TYPE: UNDISTURBED, PRECUT

NORMAL STRESS, T/SF: 2.4

REMARKS:

PROJECT: CHASKA

BORING NO: 82-41 SAMPLE NO: 4

DEPTH:

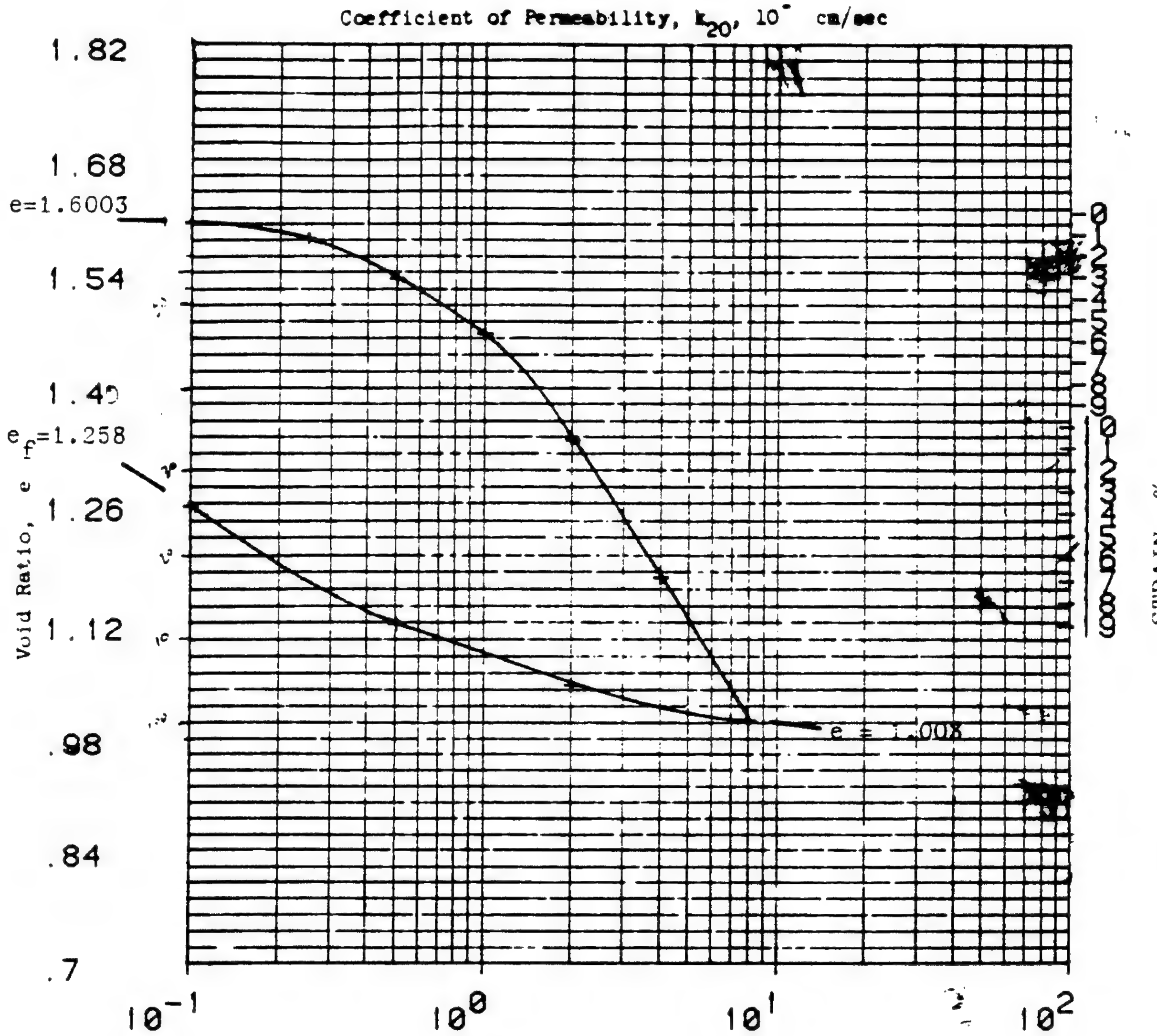
MRD LAB NO: 83/87 DATE: 17 FEB 1983

RESIDUAL DIRECT SHEAR TEST REPORT

FIGURE: 25

MRD Form 769, 1 May 80 (Replaces 1 Nov 68 edition)

Figure C-73

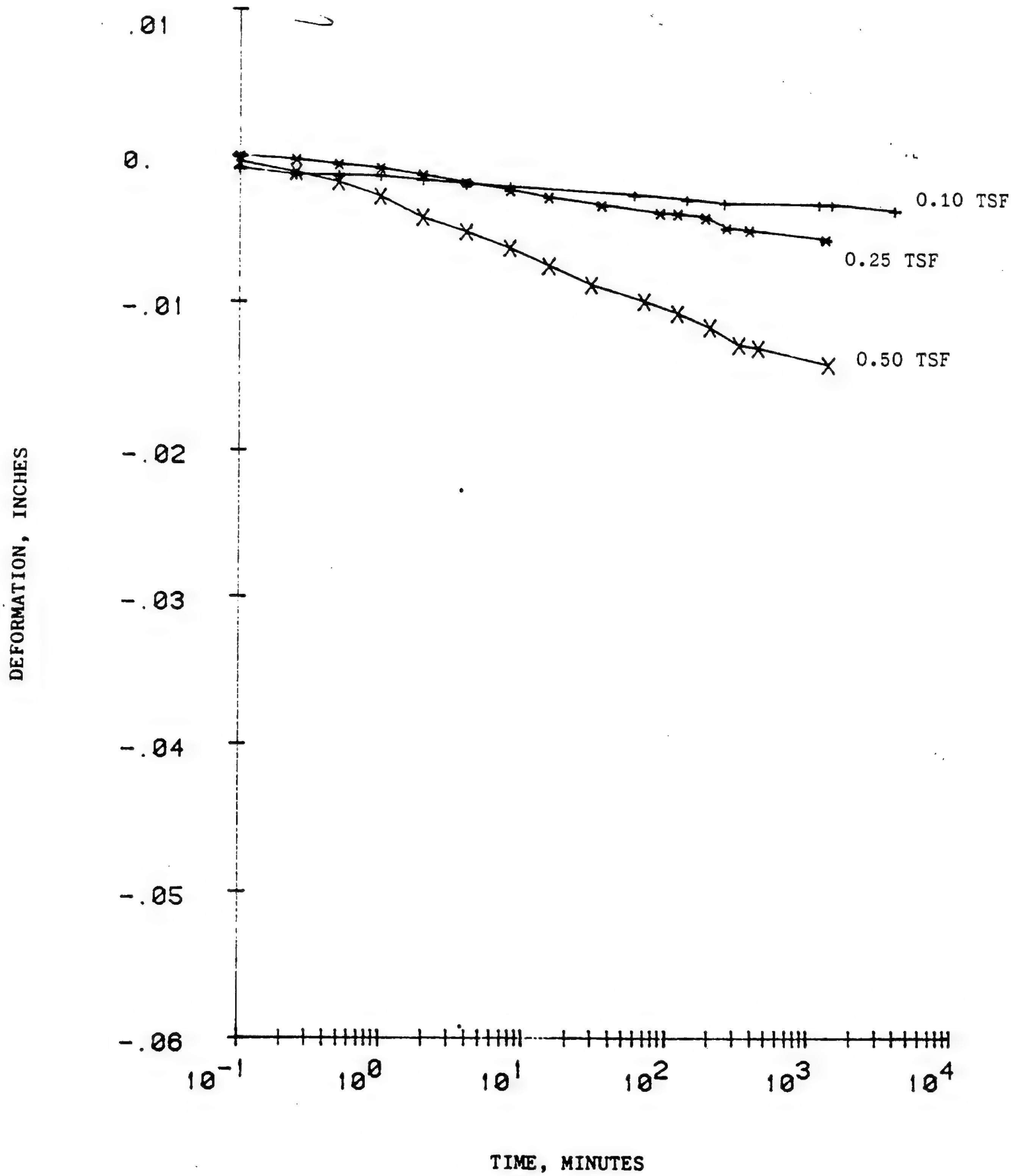


Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 2.5 in.	Ht .749 in.	Water Content, w_o	68. %	w_f	48.7 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.62	e_f	1.26
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	100. %	S_f	97. %
Compression Index, C_c		Dry Density, γ_d	59.9 lb/ft^3		
Classification Organic Fat clay, CH		k_{20} at e_o = × 10^{-} cm/sec			
LL 116	G_s 2.51	Project CHASKA NCS-IA-82-126-ED-GH			
PL 31	D_{10}				
Remarks		Area MRD LAB NO: 83/67			
		Boring No. 82-51		Sample No. 1	
		Depth El ~~[illegible]~~ 28-30		Date 7 APR 1983	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 1

Figure C-74



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67

DATE: 7 APR 1983

BORING NO: 82-51

SAMPLE NO: 1

DEPTH/ELEV: 2.0-3.0

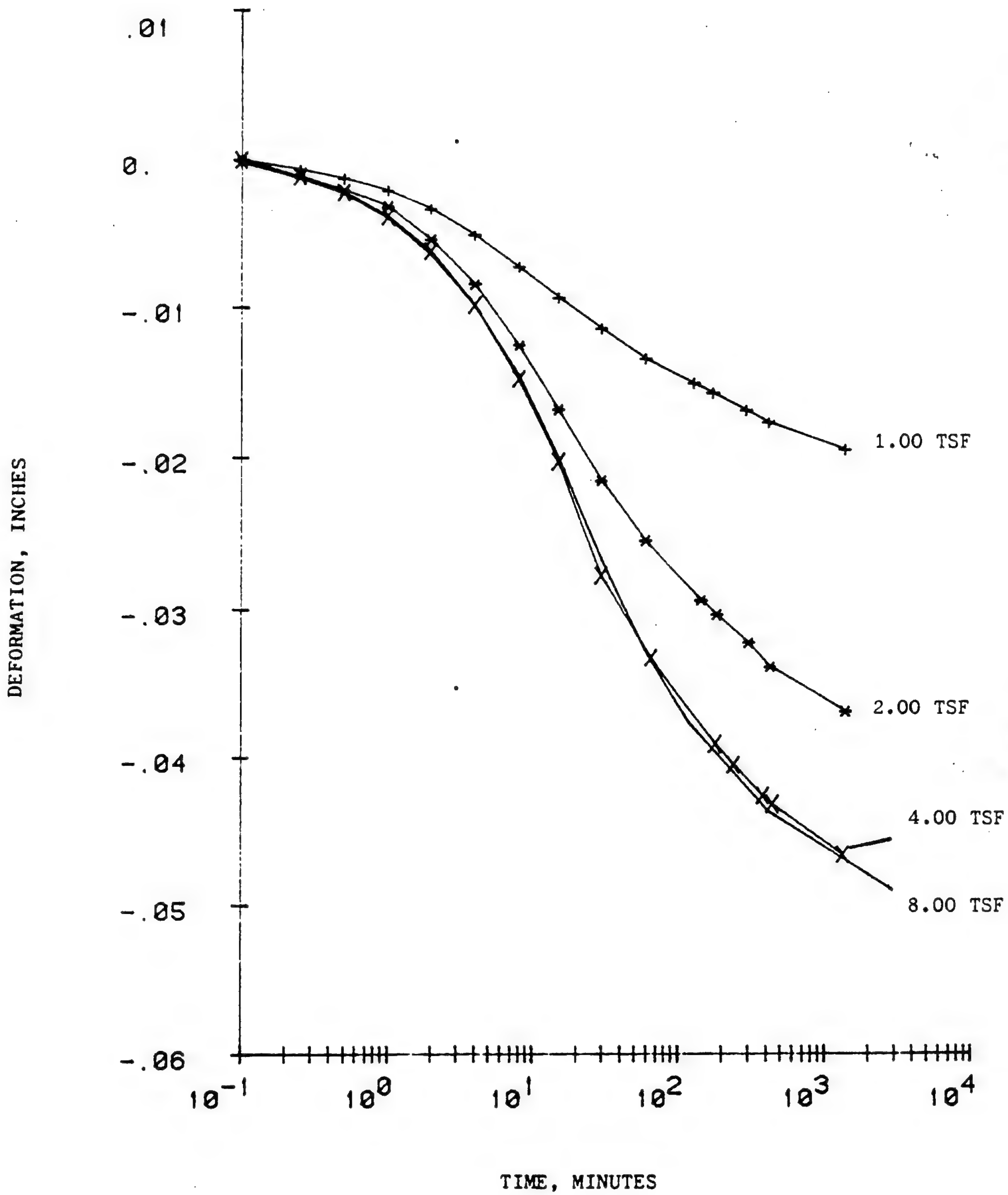
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 2

Figure C-75

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67

DATE: 7 APR 1983

BORING NO: 82-51

SAMPLE NO: 1

DEPTH/ELEV: 2.0-3.0

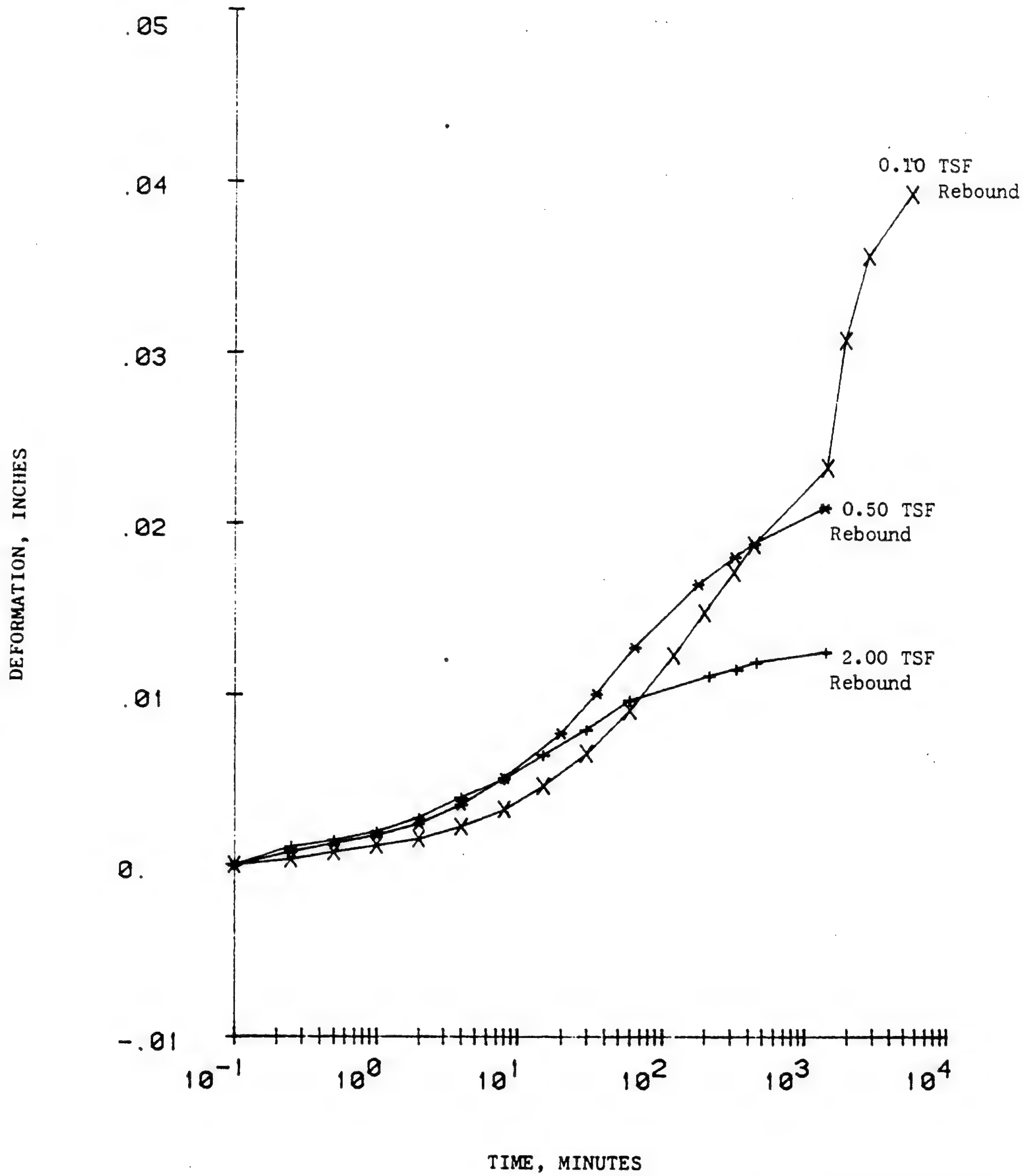
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 3

Figure C-76

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67

DATE: 7 APR 1983

BORING NO: 82-51

SAMPLE NO: 1

DEPTH/ELEV: 2.0-3.0

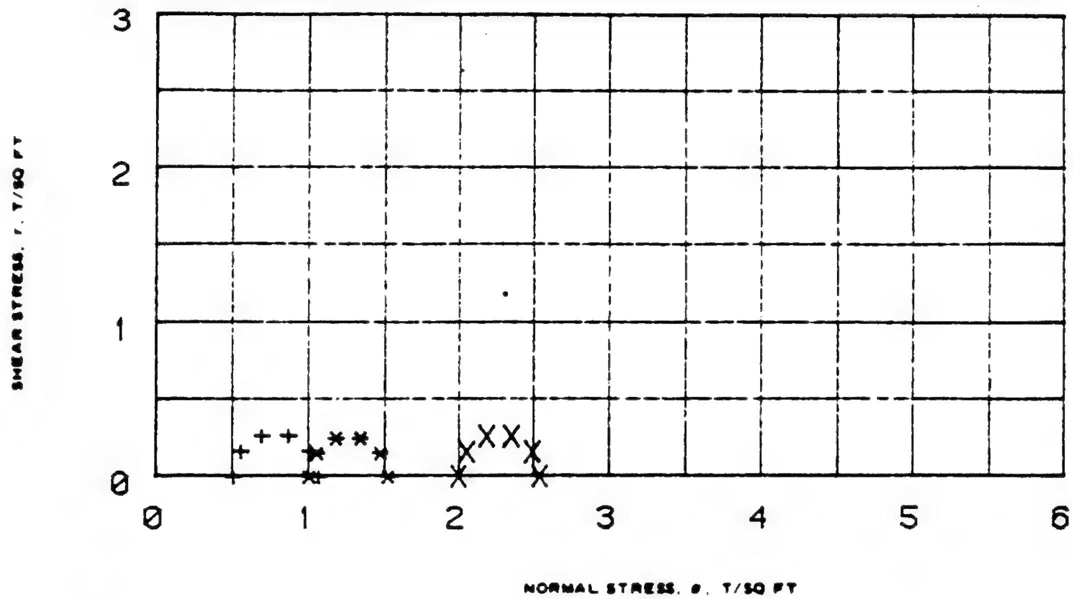
CONSOLIDATION TEST--TIME CURVES

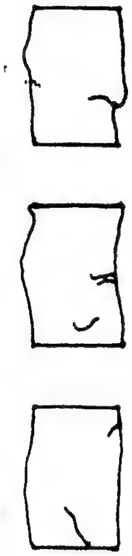
COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

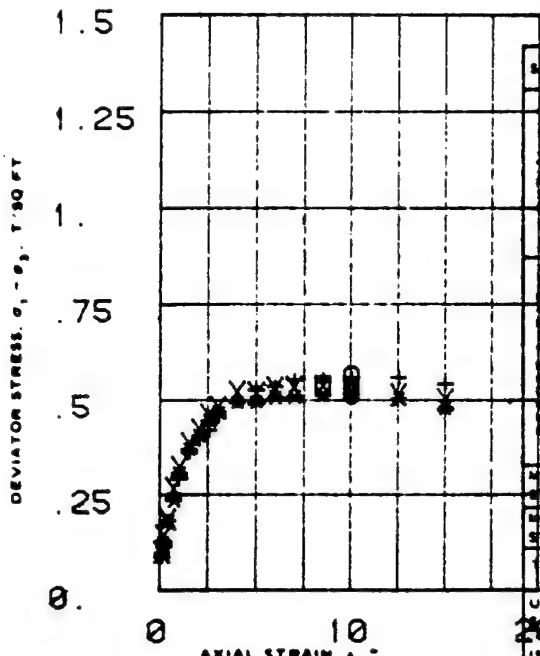
FIGURE: 4

Figure C-77

MRD Form 956, 1 May 80







			SPECIMEN NO	1	2	3
INITIAL	WATER CONTENT, %	w_o		72.	78.5	73.3
	DRY DENSITY LB/CU FT	γ_{d_o}		56.2	52.8	55.5
	SATURATION, %	S_o		100.	100.	100.
	VOID RATIO	e_o		1.79	1.97	1.82
BEFORE SHEAR	WATER CONTENT, %	w_c		71.8	73.3	73.2
	DRY DENSITY LB/CU FT	γ_{d_c}		56.2	52.8	55.5
	SATURATION, %	S_c		100.	94.	100.
	VOID RATIO	e_c		1.79	1.97	1.82
	FINAL BACK PRESSURE, T/SQ FT	u_o		0.	0.	0.
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3		.5	1.	2.
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$		.561	.518	.537
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f		21	21	18
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$		.544	.48	.499
INITIAL DIAMETER, IN		D_o		1.39	1.39	1.4
INITIAL HEIGHT, IN		H_o				

CONTROLLED- TEST

DESCRIPTION OF SPECIMENS Organic fat clay, CH

LL 116	PL 31	PI 85	G_s 2.51	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Dark gray with light gray streaks, soft consistency, high strength at PL, high gloss shine, slow shake response, some shell fragments. Sample was disturbed (See Plate 1).

PROJECT CHASKA NCS-IA-82-128-ED-GH

BORING NO 82-51 SAMPLE NO 1

DEPTH/ELEV 28-30

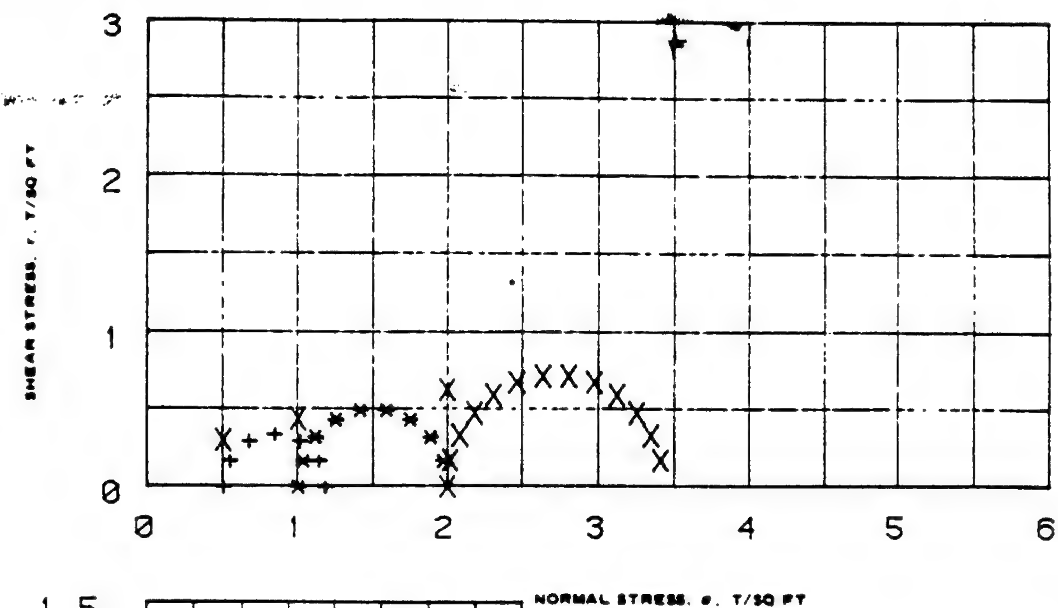
LABORATORY 83/87 DATE 08 MAR 1983

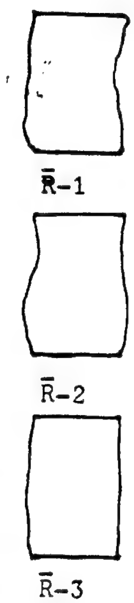
TRIAXIAL COMPRESSION TEST REPORT

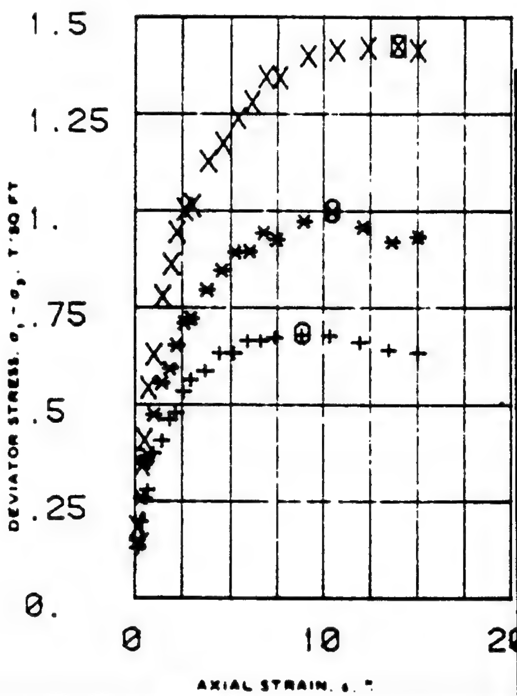
ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Shear strengths may represent remolded strengths.

Figure 17







SPECIMEN NO.			1	2	Y3	
INITIAL	WATER CONTENT, %	w_o	61.	57.2	60.1	
	DRY DENSITY LB/CU FT	γ_{d_o}	61.3	64.1	62.1	
	SATURATION, %	S_o	98.	99.	99.	
	VOID RATIO	e_o	1.66	1.44	1.52	
BEFORE SHEAR	WATER CONTENT, %	w_c	58.8	48.3	45.5	
	DRY DENSITY LB/CU FT	γ_{d_c}	63.5	69.3	71.6	
	SATURATION, %	S_c	97.	98.	98.	
	VOID RATIO	e_c	1.47	1.26	1.19	
	FINAL BACK PRESSURE, T/SQ FT	u_o	2.66	2.66	2.66	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.686	1.	1.43	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	840	980	1280	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.835	.923	1.41	
INITIAL DIAMETER, IN		D_o	1.39	1.39	1.4	
INITIAL HEIGHT, IN		H_o	3.	3.	2.99	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Organic fat clay, CH

LL 116	PL 31	PI 85	Gs 2.51	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST R̄

REMARKS

B value = 1.00

PROJECT CHASKA NCS-IA-B2-120-ED-GH

BORING NO. 82-51 SAMPLE NO. 1

DEPTH ELEV 20.-30.

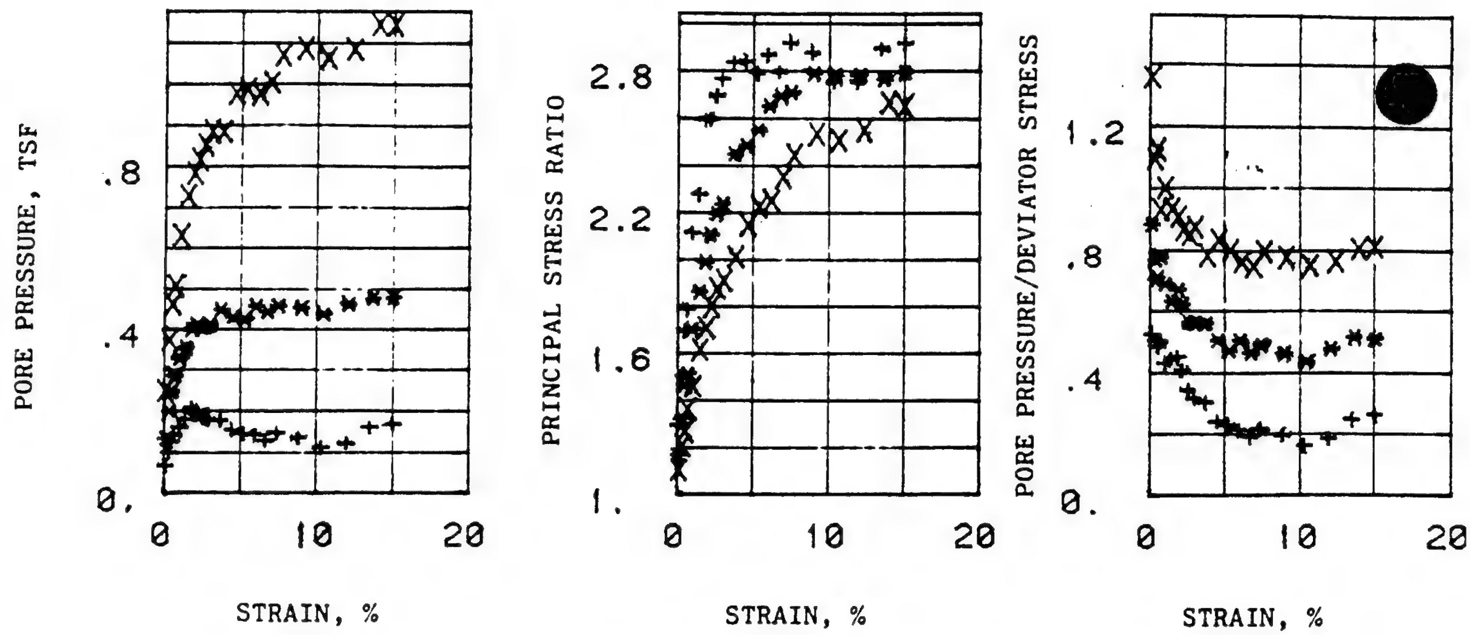
LABORATORY 85/87 DATE 08 MAR 1983

TRIAXIAL COMPRESSION TEST REPORT

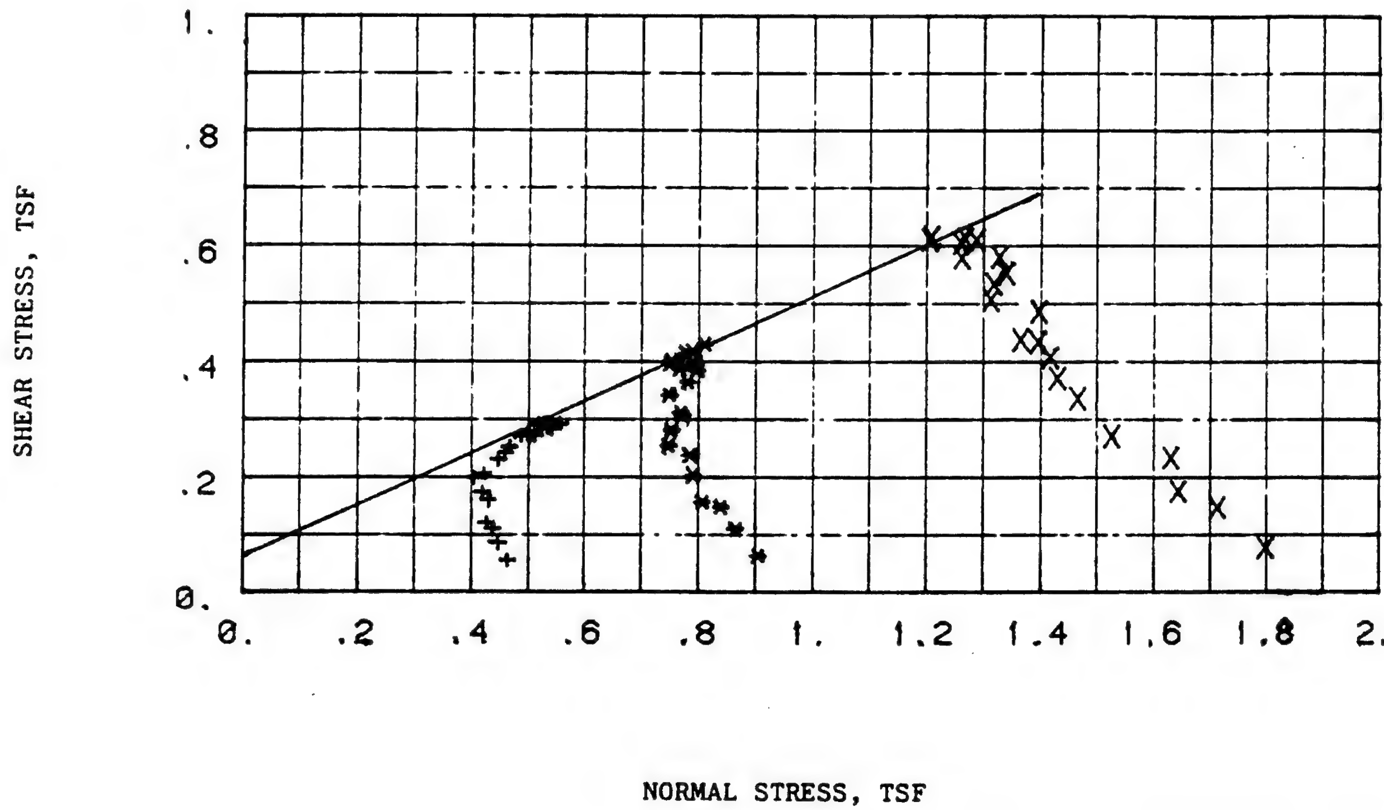
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 18

Figure C-79



EFFECTIVE STRESS VECTOR CURVES ON 60. DEGREE PLANE



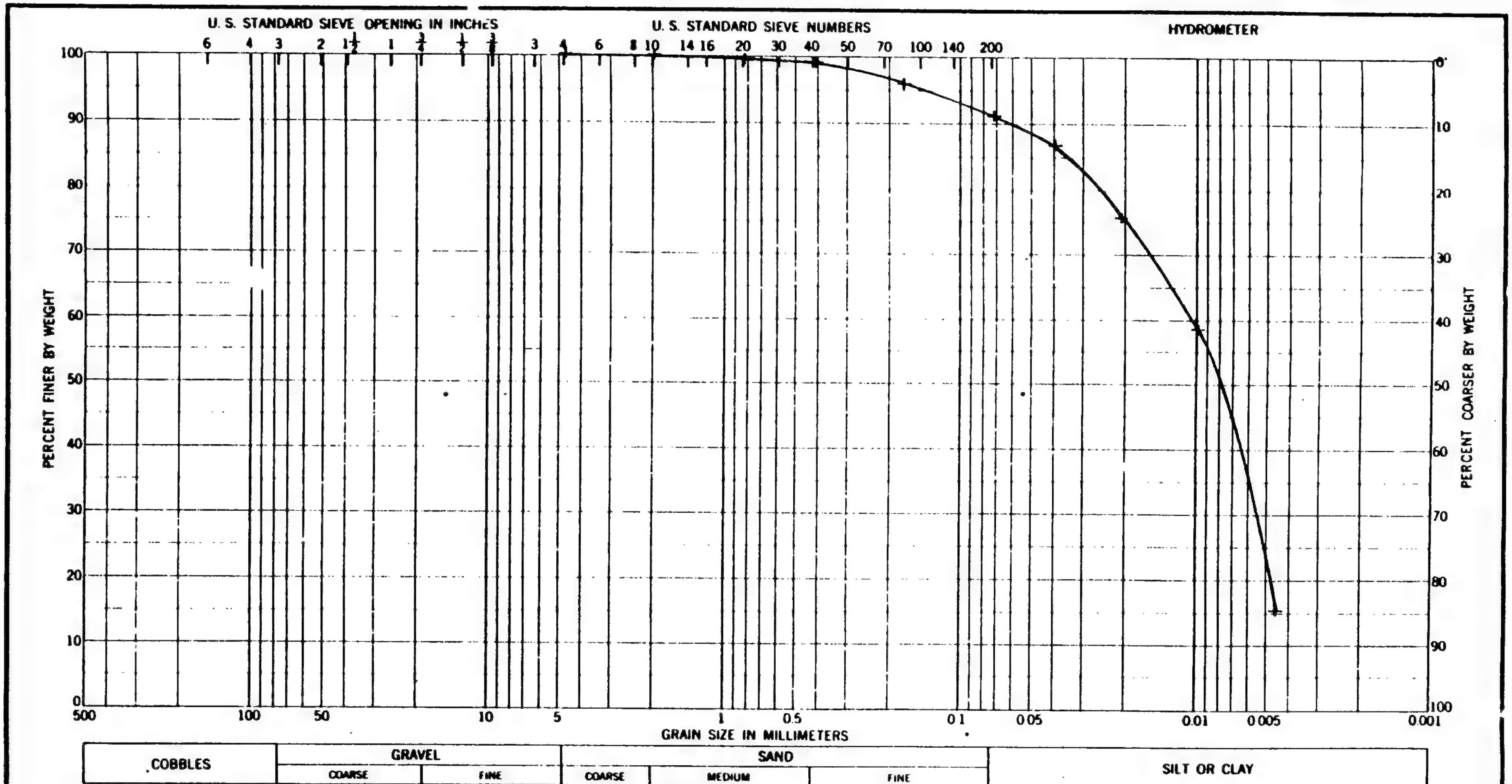
REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

PROJECT:	CHASKA NCS-IA-82-126-ED-GM
BORING NO:	82-51
SAMPLE NO:	1
DEPTH/ELEV:	28.-38.
MRD LAB NO:	83/87
DATE:	08 MAR 1983

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 19

MRD Form 756, 1 May 80



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	28.-30.	Organic fat clay, CH		116	31	85

Project	CHASKA NCS-IA-82-126-ED-GH
Area	MRD LAB NO. 83/67
Boring No.	82-51
Date	08 MAR 1983

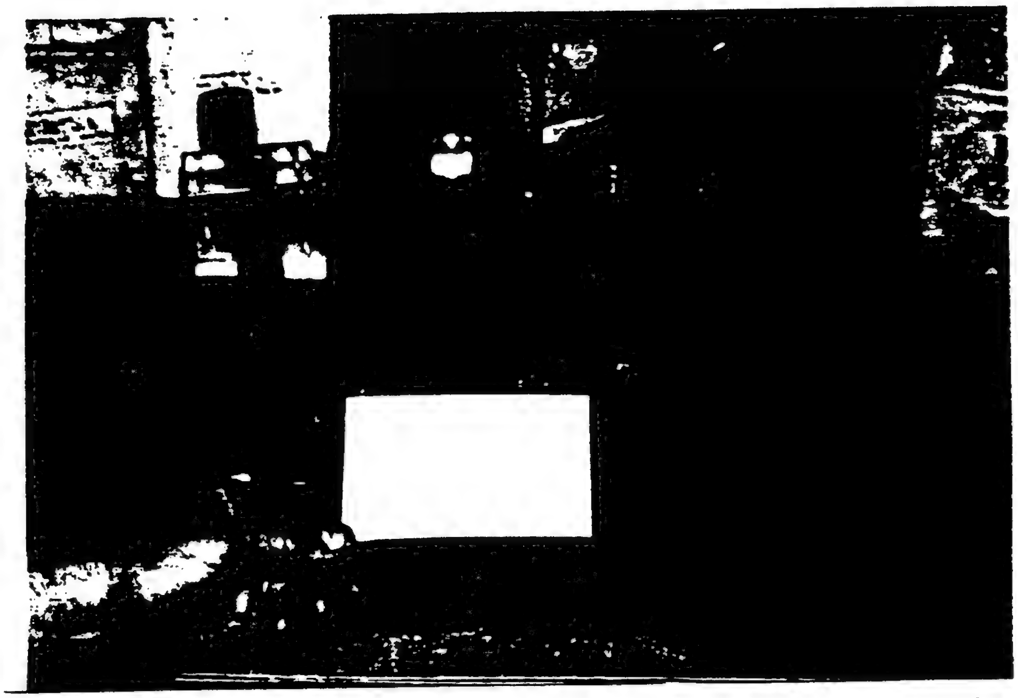
GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 20

Figure C-81

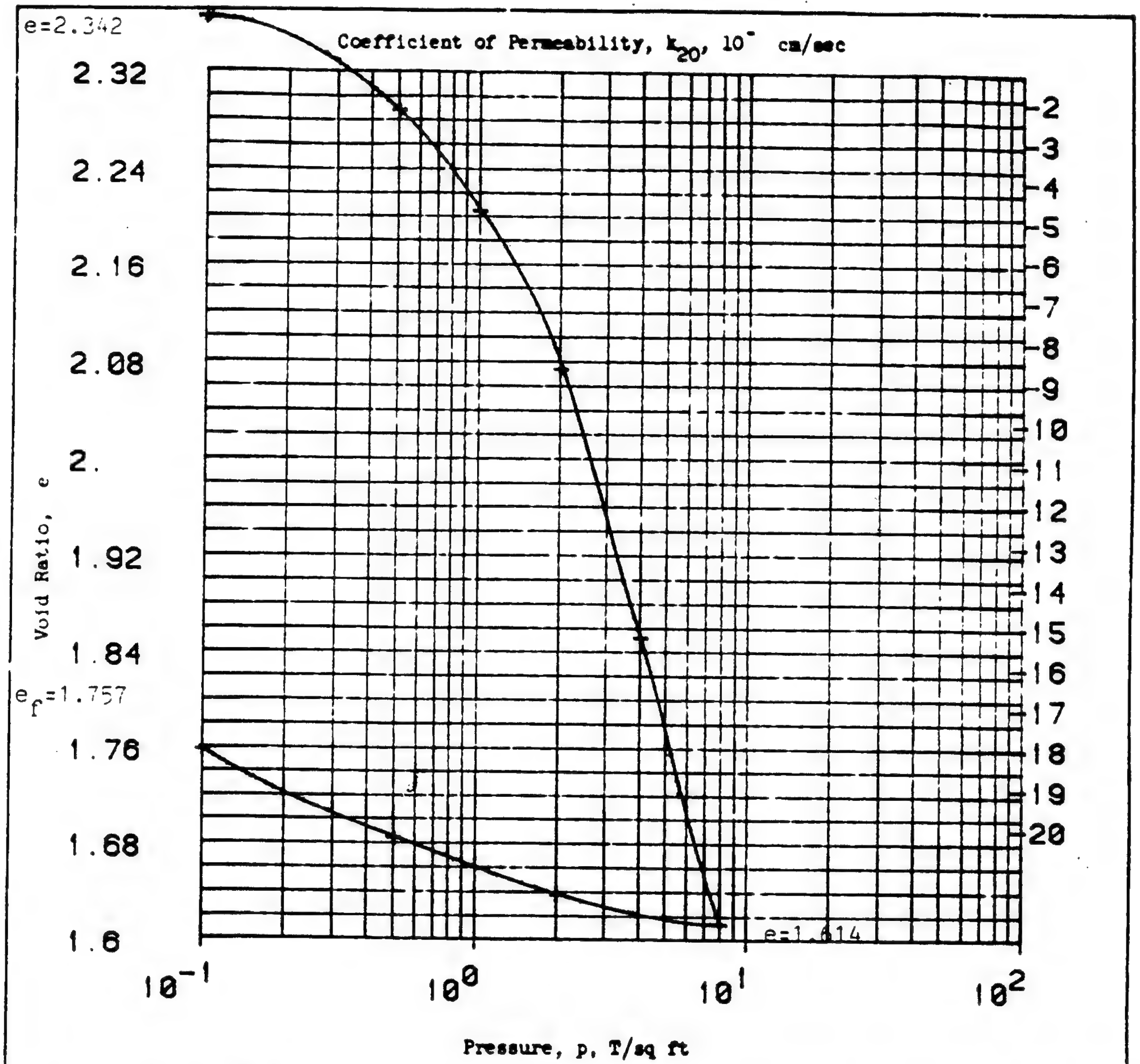
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska



Disturbed Boring 82-51 Sample 1.

Plate 1

Figure C-82

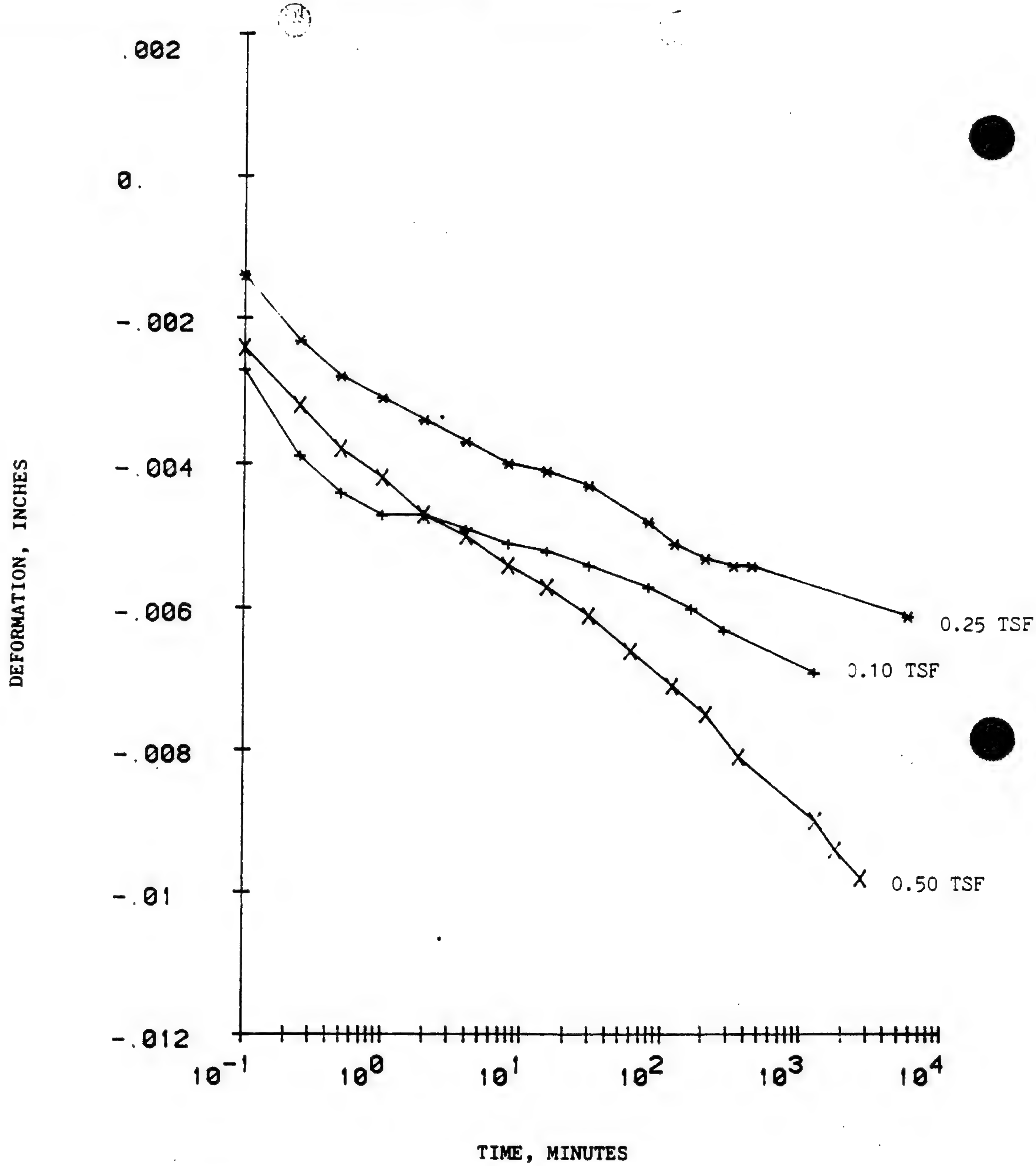


Type of Specimen UNDIST		Before Test		After Test	
Diam 4.29 in.	Ht 1. in.	Water Content, w_o	82.8 %	w_f	61.3 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	2.37	e_f	1.76
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	95. %	S_f	95. %
Compression Index, C_c		Dry Density, γ_d	58.2 lb/ft^3		
Classification Clayey silt, MH		k_{20} at e_o = x 10⁻ cm/sec			
LL 81	G_s 2.71	Project CHASKA			
PL 37	D_{10}				
Remarks		Area MRD LAB NO: 84/34			
		Boring No. 83-53 MU		Sample No. S-1	
		Depth El 17.0-19.0		Date 27 DEC 1983	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 8

Figure C-83



PROJECT: CHASKA

MRD LAB NO: 84/34 DATE: 27 DEC 1983

BORING NO: 83-53 MU SAMPLE NO: S-1 DEPTH/ELEV: 17.0-19.0

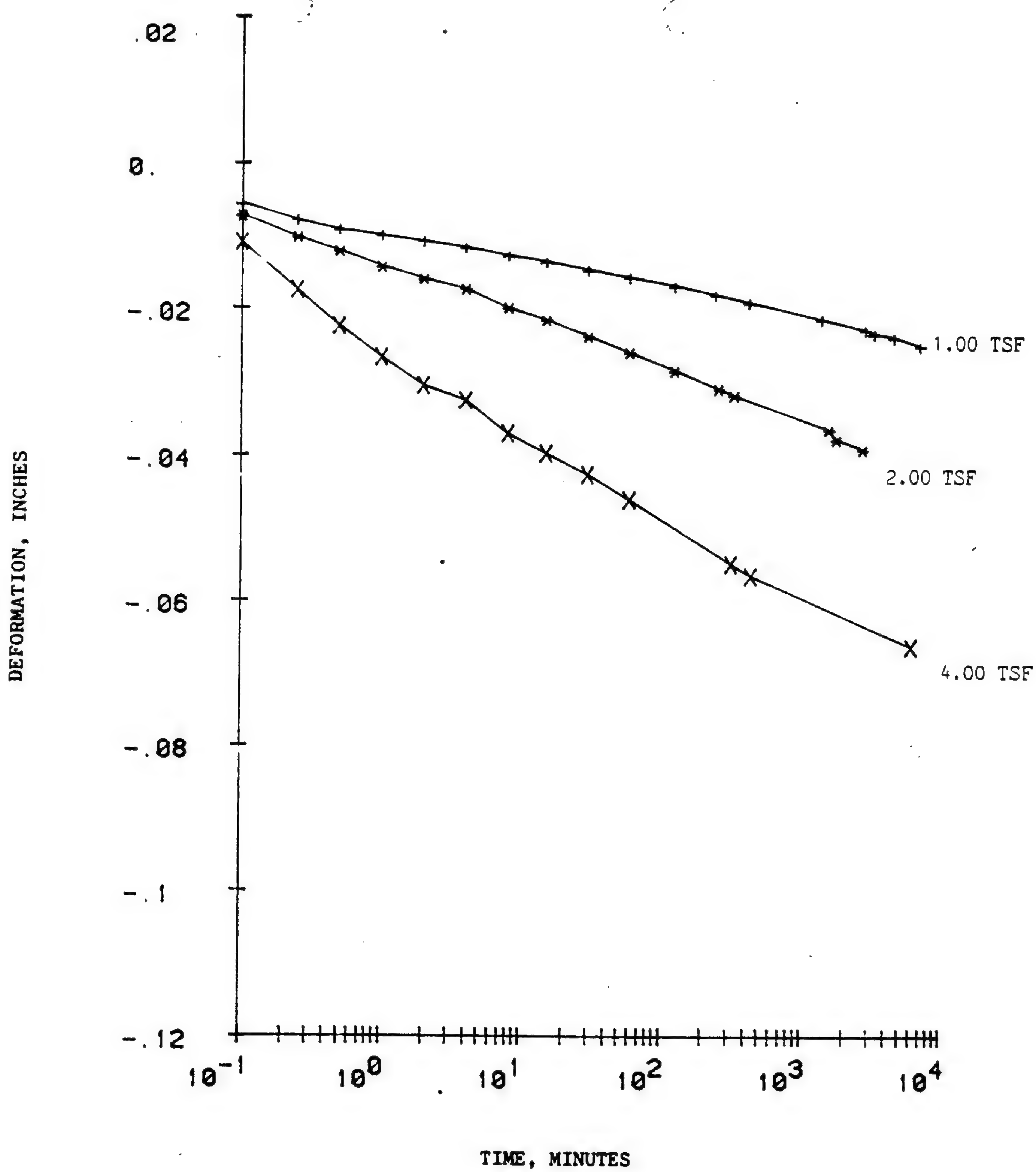
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 9

Figure C-84

MRD Form 956, 1 May 80



PROJECT: CHASKA

MRD LAB NO: 84/34

DATE: 27 DEC 1983

BORING NO: 83-53 MU

SAMPLE NO: S-1

DEPTH/ELEV: 17.0-19.0

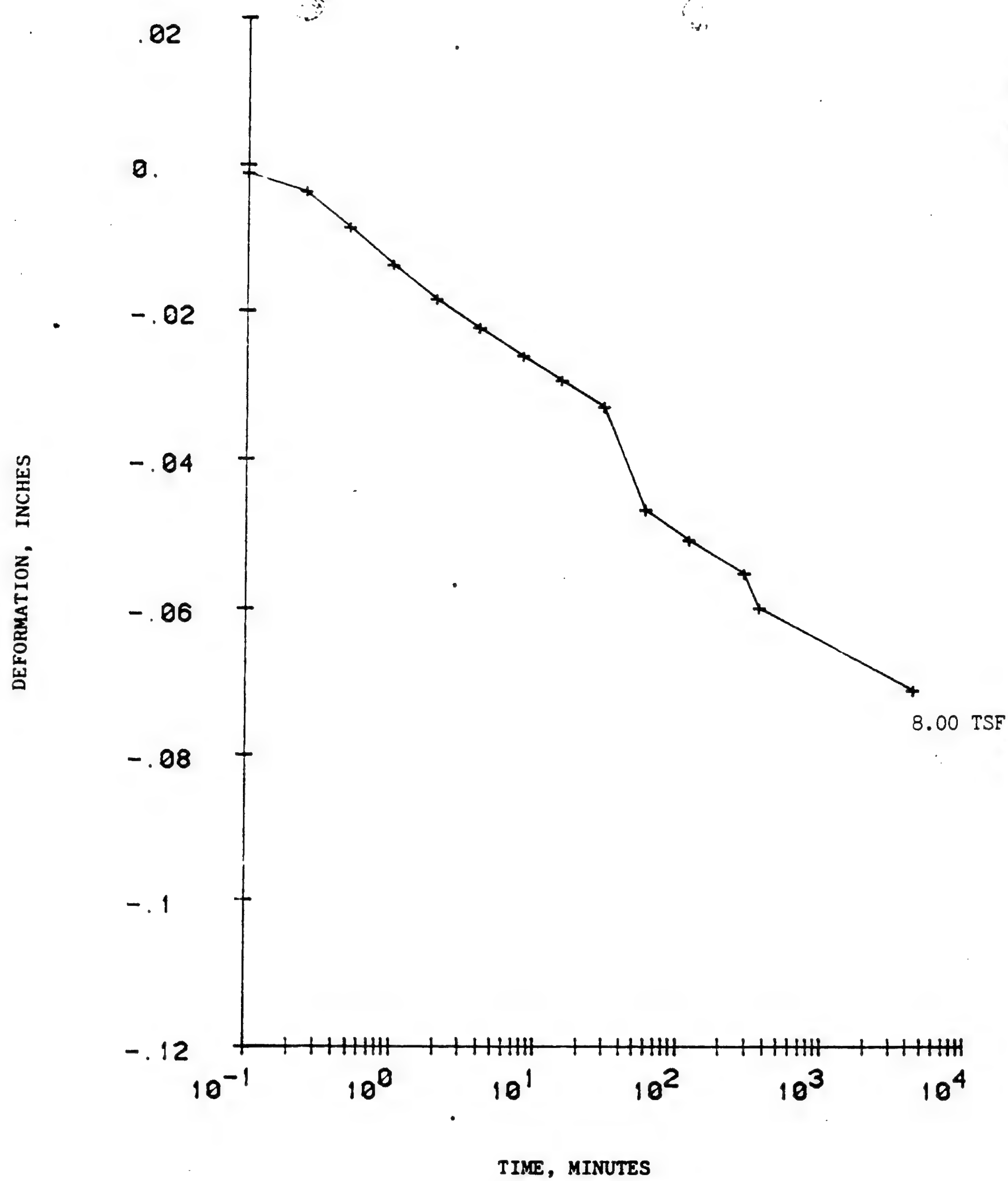
COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 10

Figure C-85

MRD Form 956, 1 May 80



PROJECT: CHASKA

MRD LAB NO: 84/34

DATE: 27 DEC 1983

BORING NO: 83-53 MU

SAMPLE NO: S-1

DEPTH/ELEV: 17.0-19.0

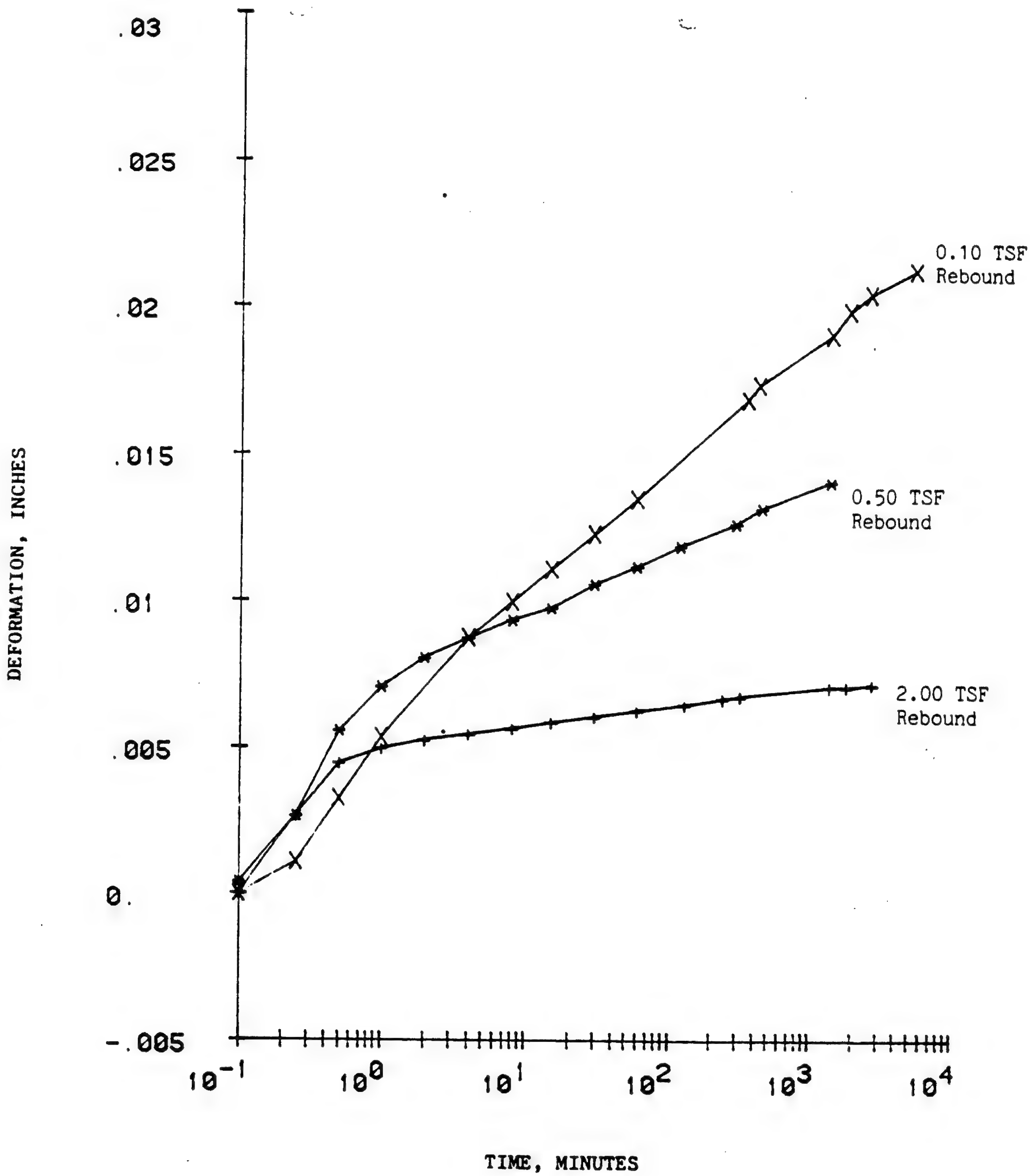
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 11

Figure C-86

MRD Form 956, 1 May 80



PROJECT: CHASKA

MRD LAB NO: 84/34

DATE: 27 DEC 1983

BORING NO: 83-53 MU

SAMPLE NO: S-1

DEPTH/ELEV: 17.0-19.0

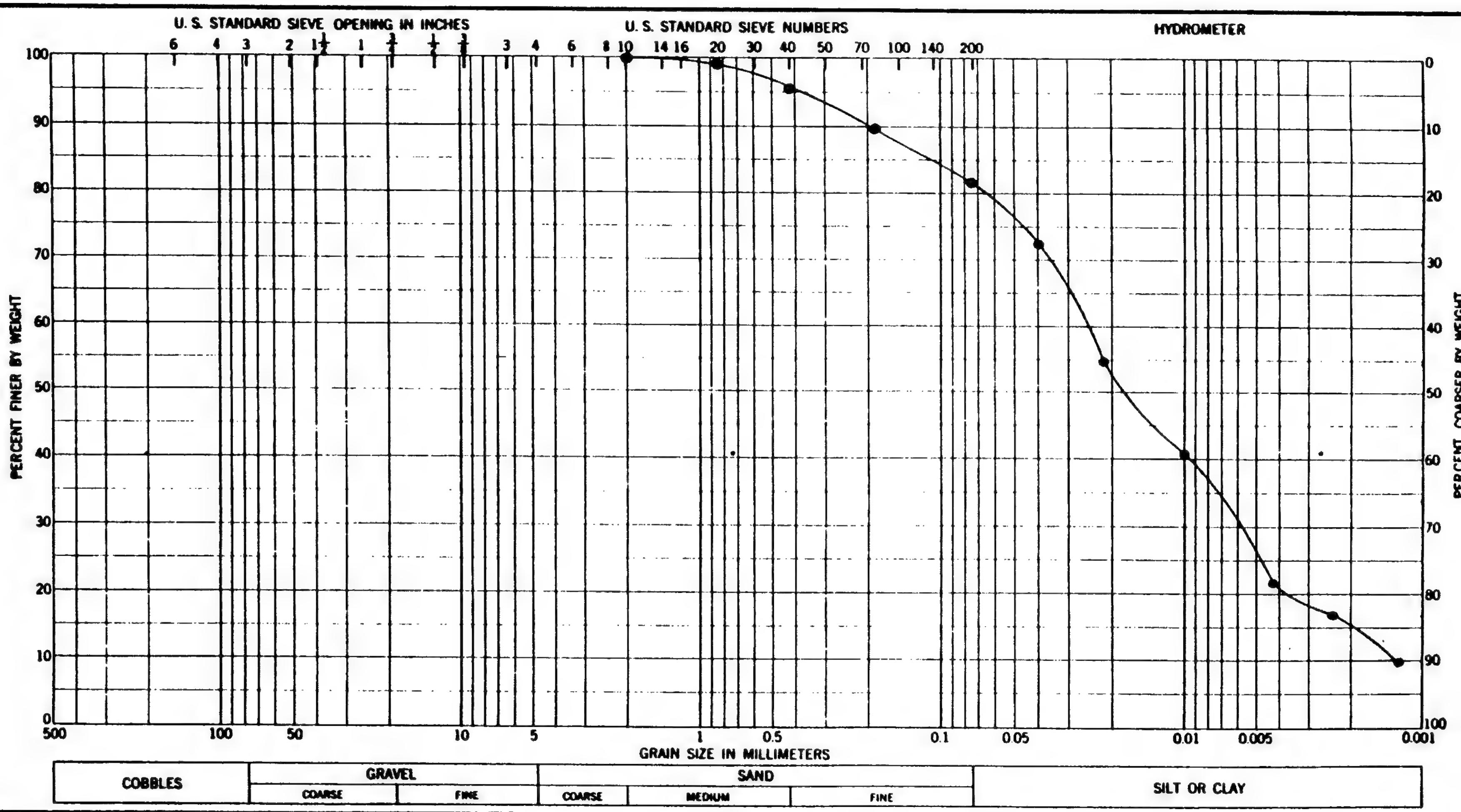
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 12

Figure C-87

MRD Form 956, 1 May 80



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	17.0-19.0	Clayey silt, MH		81	37	44

Project Chaska NCS-IA-84-4-ED-GH

Area MRD Lab No. 84/34

Boring No. 83-53

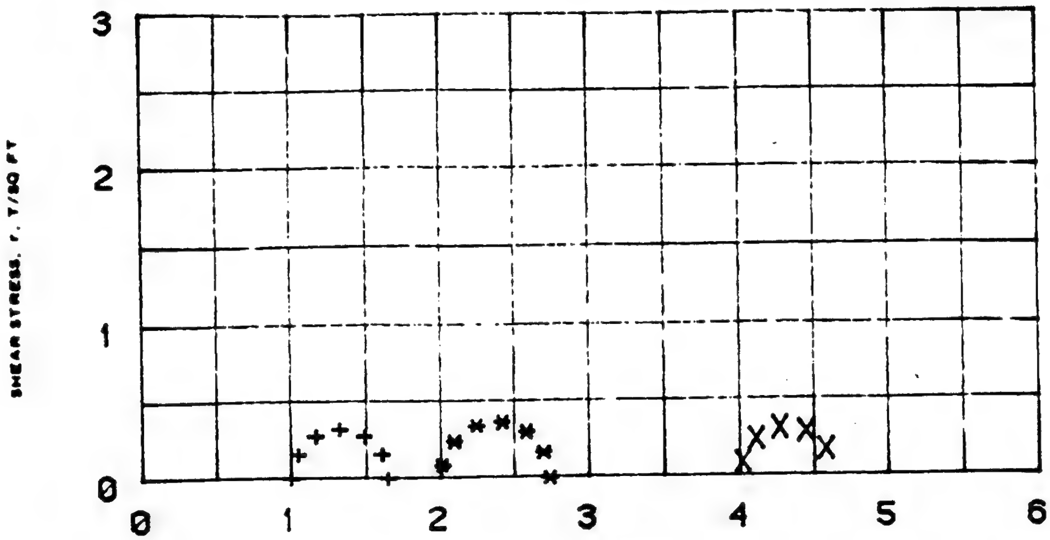
Date 27 DEC 1983

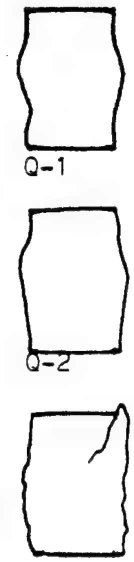
GRADATION CURVES

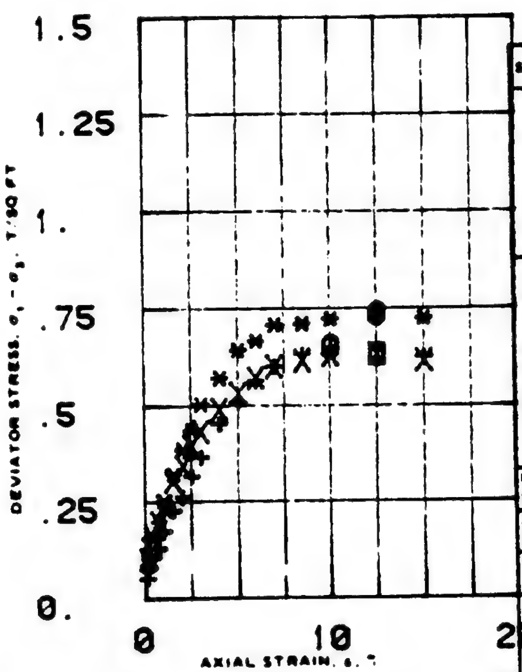
ENG FORM 1 MAY 63 2087

Figure 13

Figure C-88







SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	72.1	67.8	75.9	
	DRY DENSITY LB/CU FT	γd_o	56.1	58.8	54.6	
	SATURATION, %	S_o	97.	97.	98.	
	VOID RATIO	e_o	2.02	1.89	2.11	
BEFORE SHEAR	WATER CONTENT, %	w_c	71.9	67.4	75.7	
	DRY DENSITY LB/CU FT	γd_c	56.1	58.8	54.6	
	SATURATION, %	S_c	97.	97.	97.	
	VOID RATIO	e_c	2.02	1.89	2.11	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.649	.756	.882	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	19	25	25	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.620	.728	.815	
INITIAL DIAMETER, IN.		D_o	1.39	1.39	1.39	
INITIAL HEIGHT, IN.		H_o	3.00	3.00	2.99	

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Clayey silt, MH

LL 81	PL 37	PI 44	G_s 2.71	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Dark gray, medium consistency, low to medium strength at PL, dull shine, slow to medium shake response, highly calcareous, organic odor, sea shells.

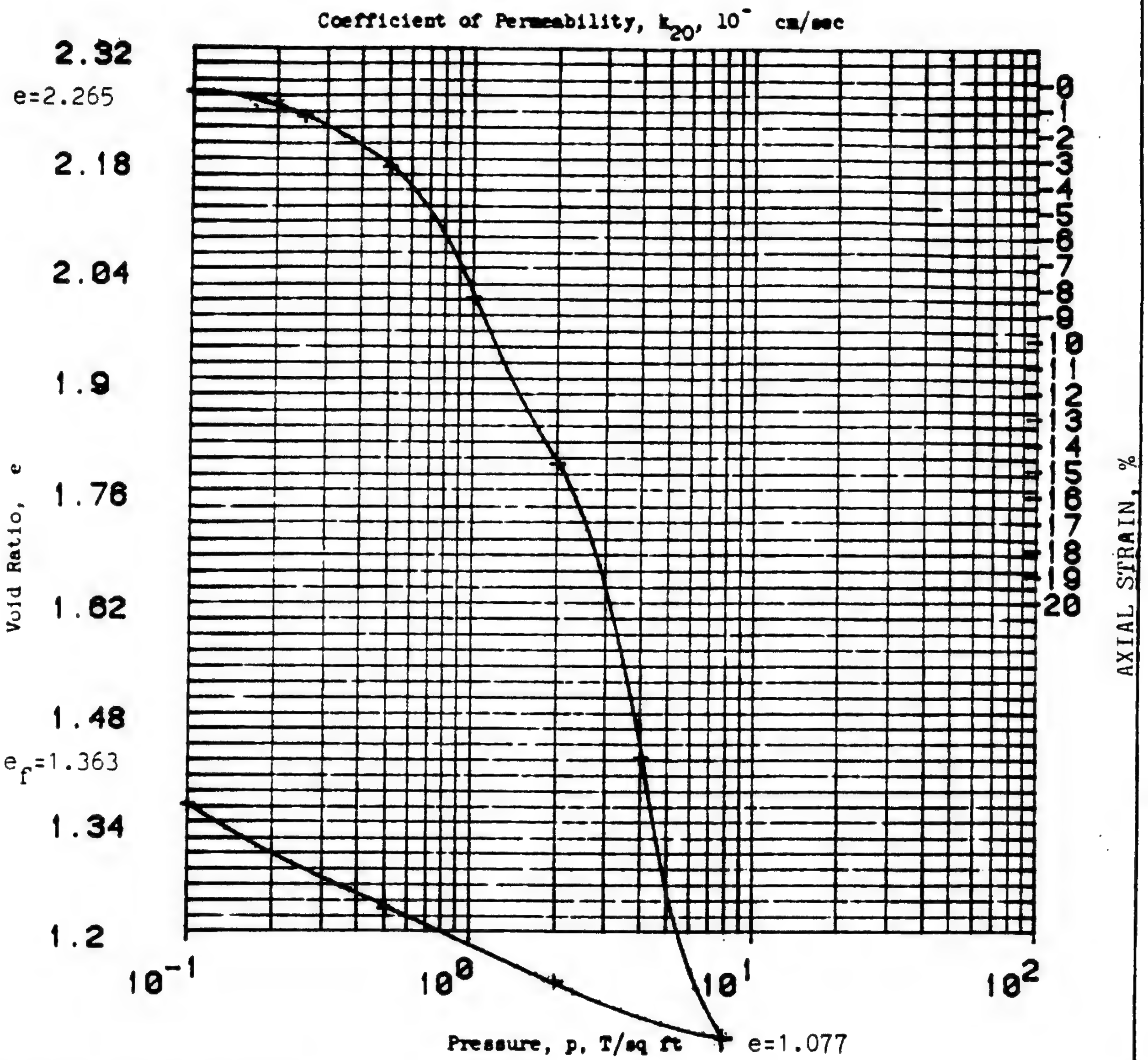
PROJECT CHASKA NCS-IA-84-4-ED-GH

BORING NO 83-53 | SAMPLE NO. 1

DEPTH ELEV 17.0-19.0

LABORATORY 84/84 | DATE 27 DEC 1983

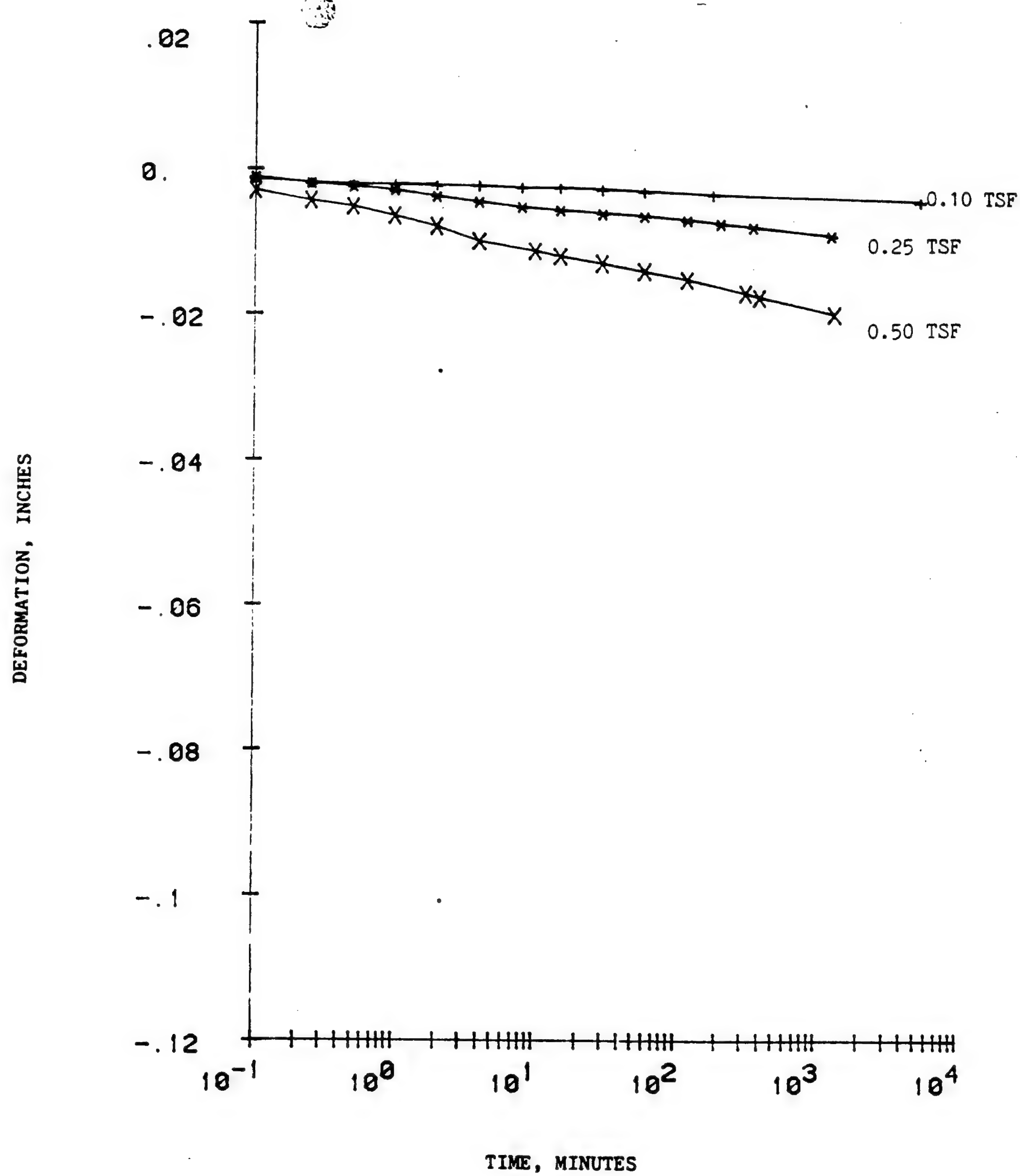
TRIAXIAL COMPRESSION TEST REPORT



Type of Specimen UNDIST				Before Test		After Test	
Diam 4.29 in.		Ht 1. in.		Water Content, w_o	73.7 %	w_f	97.1 %
Overburden Pressure, Po T/sq ft				Void Ratio, e_o	2.28	e_f	1.38
Preconsol. Pressure, Pc T/sq ft				Saturation, S_o	76. %	S_f	100. %
Compression Index, C_c				Dry Density, γ_d	44.9 lb/ft^3		
Classification Sandy Organic, OH				k_{20} at e_o = x 10^{-} cm/sec			
LL 207		G_s 2.38		Project CHASKA NCS-IA-84-4-ED-GH			
PL 74		D_{10}					
Remarks Sample contained				Area MRD LAB NO: 84/34			
numerous shells.				Boring No. 83-53 MU		Sample No. S-2	
				Depth El 26.0-28.0		Date 10 JAN 1984	
				CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 1



PROJECT: CHASKA

MRD LAB NO: 84-34

DATE: 10 JAN 1984

BORING NO: 83-53 MU

SAMPLE NO: S-2

DEPTH/ELEV: 26.0-28.0

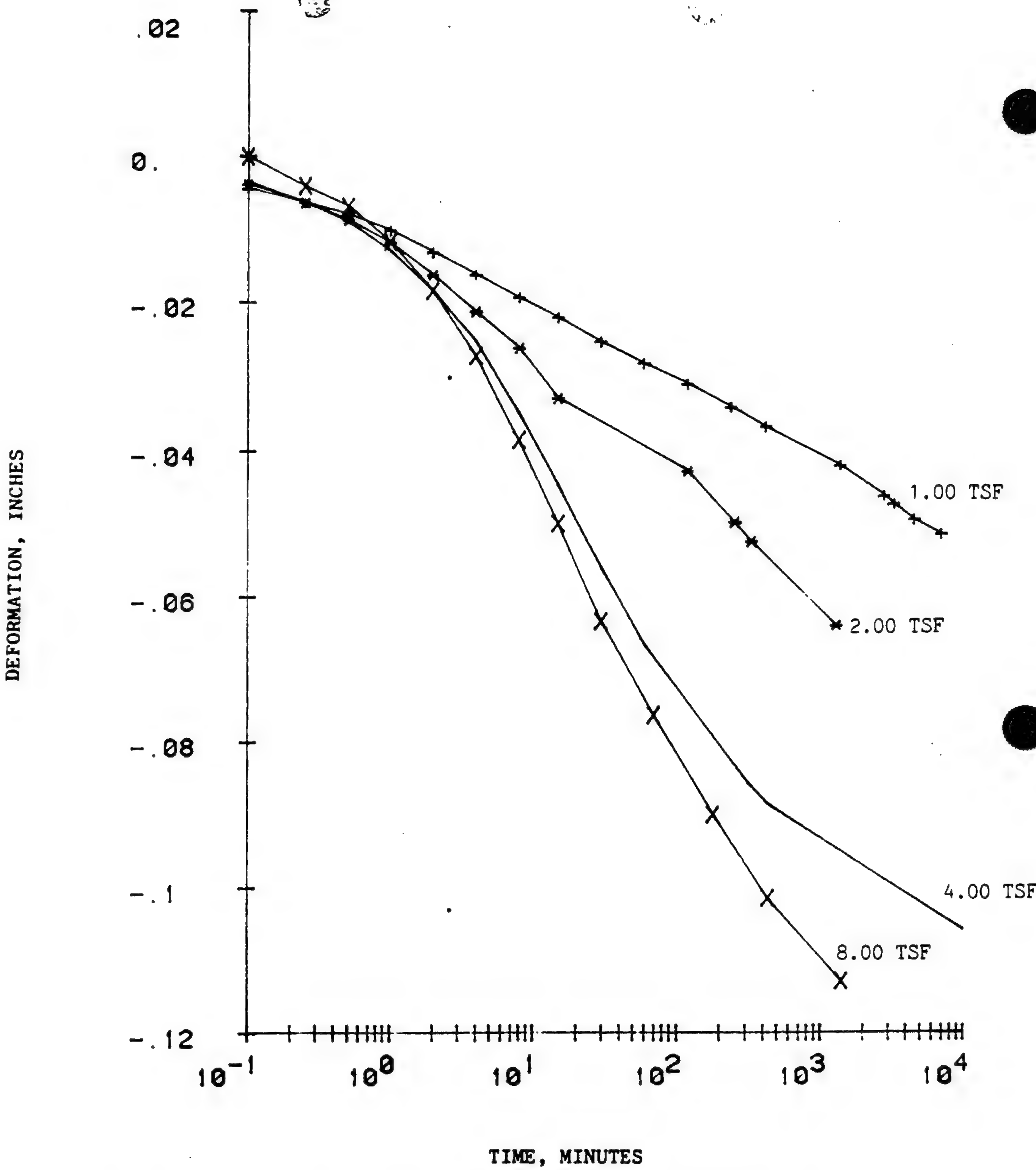
COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 2

Figure C-91

MRD Form 956, 1 May 80



PROJECT: CHASKA

MRD LAB NO: 84-34 DATE 10 JAN 1984

BORING NO: 83-53 MU SAMPLE NO: S-2 DEPTH/ELEV: 26.0-28.0

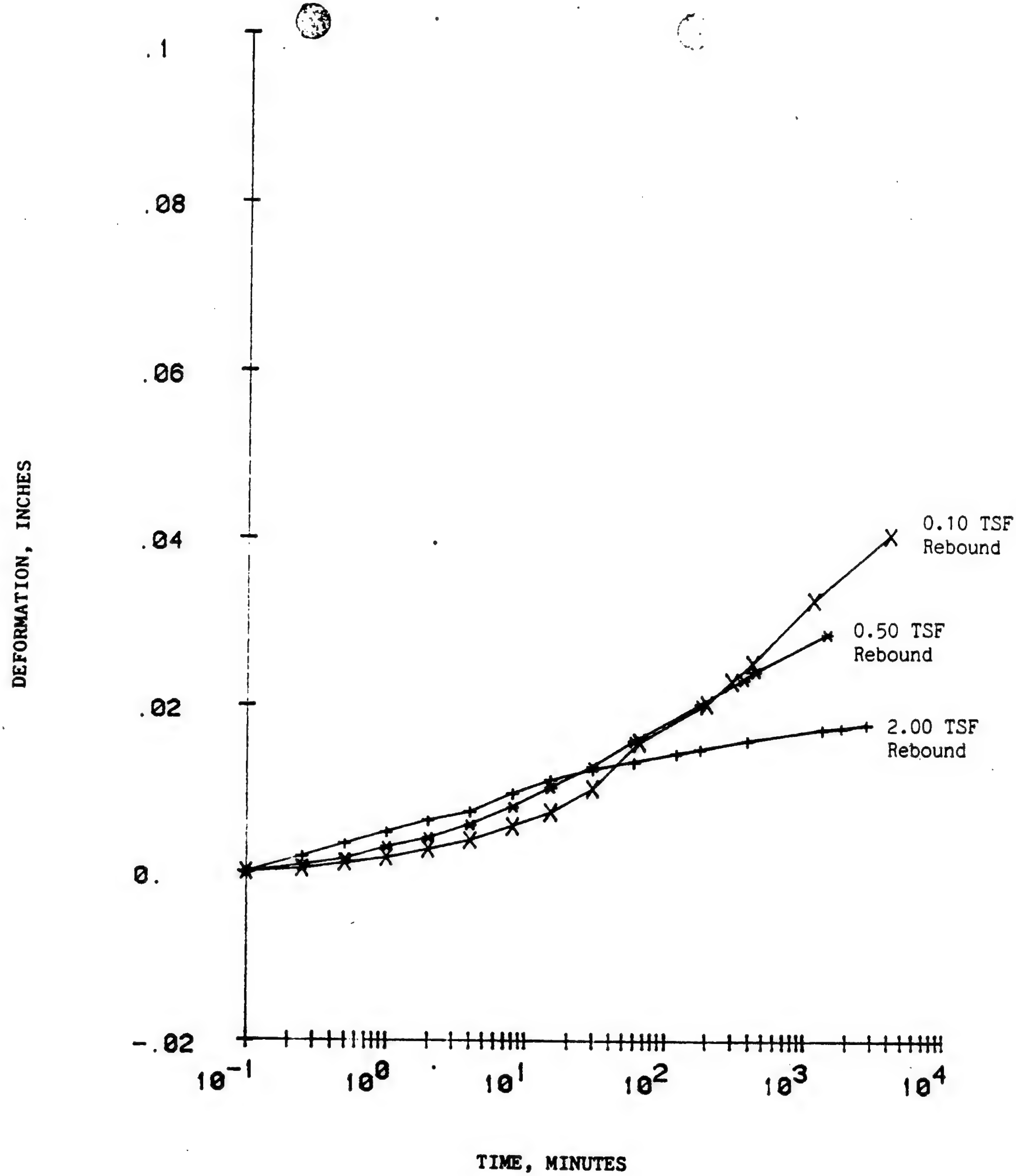
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 3

Figure C-92

MRD Form 956, 1 May 80



PROJECT: CHASKA

MRD LAB NO: 84-34

DATE: 10 JAN 1984

BORING NO: 83-53 MU

SAMPLE NO: S-2

DEPTH/ELEV: 26.0-28.0

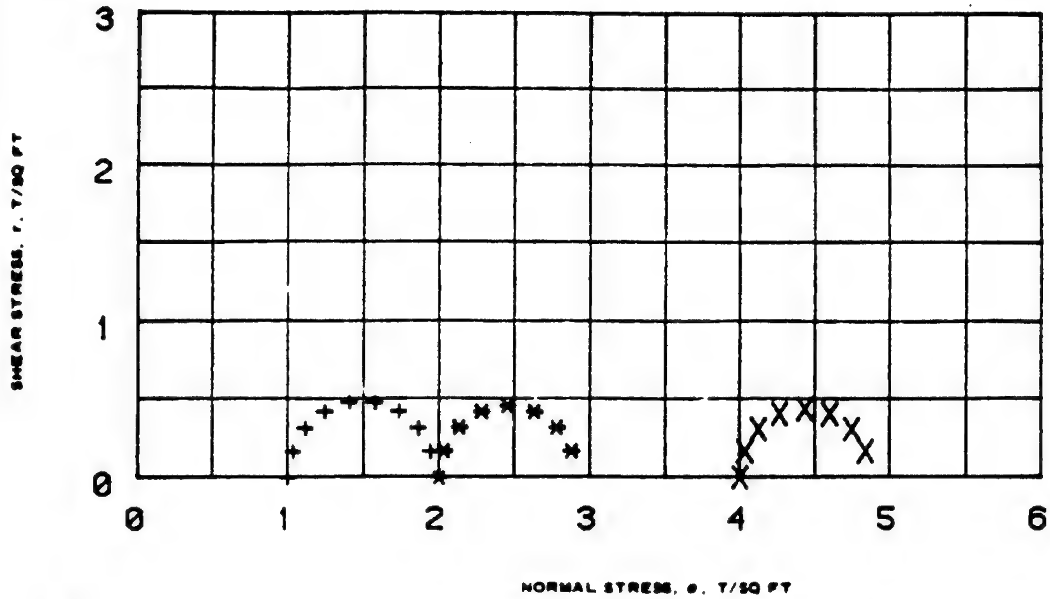
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

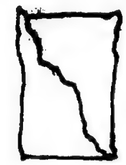
FIGURE: 4

Figure C-93

MRD Form 956, 1 May 80

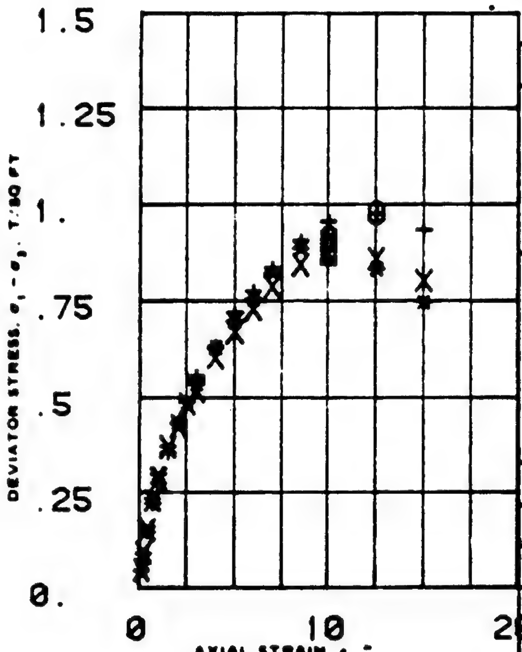


Q-1



Q-2

Q-3

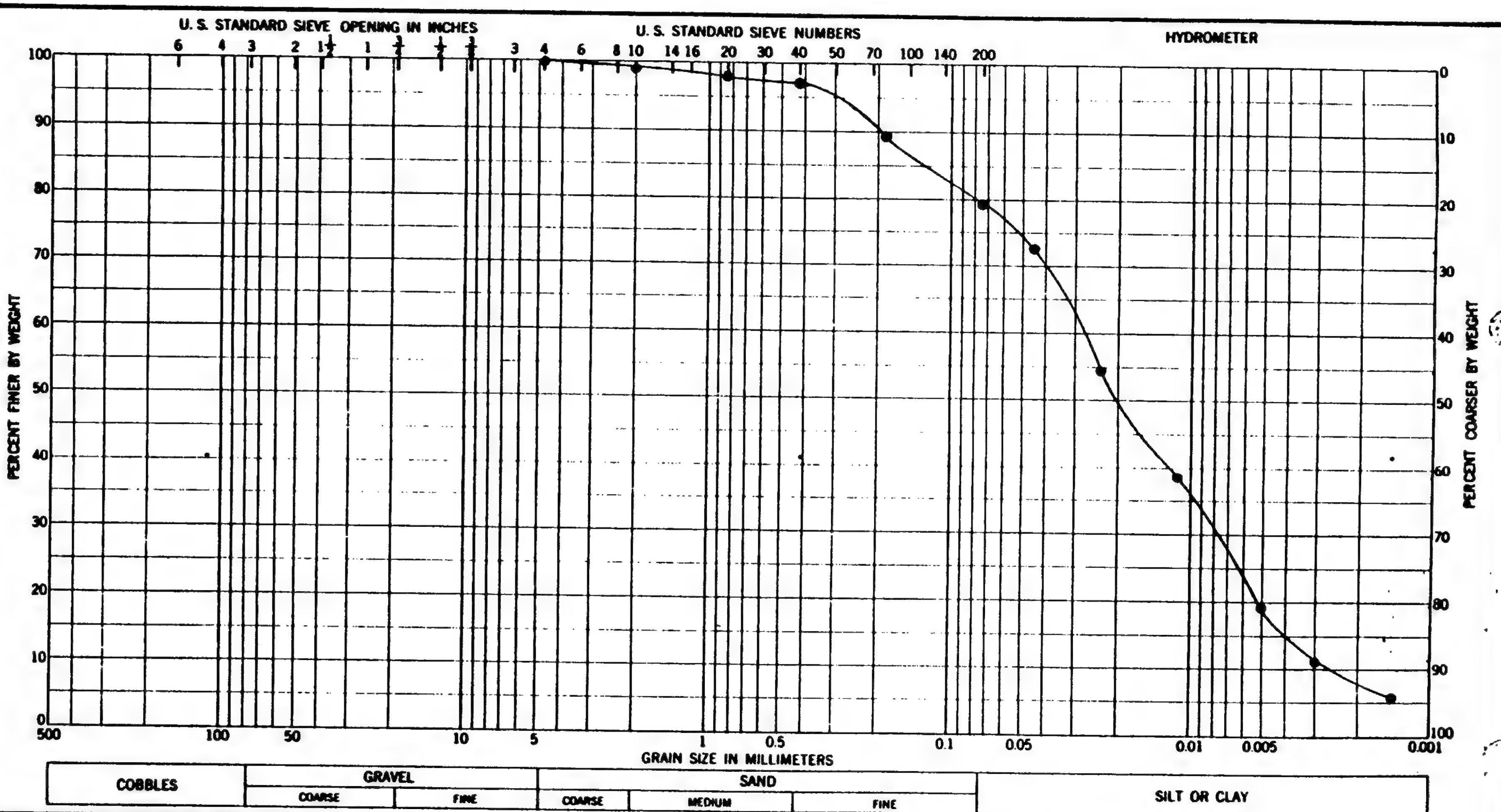


SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	135.	140.	131.	
	DRY DENSITY LB/CU FT	γ_{d_o}	34.5	33.5	35.4	
	SATURATION, %	S_o	97.	97.	98.	
	VOID RATIO	e_o	3.27	3.39	3.16	
BEFORE SHEAR	WATER CONTENT, %	w_c	135.	139.	131.	
	DRY DENSITY LB/CU FT	γ_{d_c}	34.0	33.9	35.9	
	SATURATION, %	S_c	98.	98.	100.	
	VOID RATIO	e_c	3.25	3.35	3.11	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.970	.915	.872	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	22	20	19	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.934	.749	.802	
INITIAL DIAMETER, IN.		D_o	1.41	1.4	1.39	
INITIAL HEIGHT, IN		H_o	2.95	2.98	3.00	

CONTROLLED- Strain TEST					
DESCRIPTION OF SPECIMENS Sandy organic, OH					
LL 207	PL 74	PI 133	Gs 2.38	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q
REMARKS: Dark gray, soft consistency,				PROJECT CHASKA NCS-IA-04-4-ED-GH	
low strength at PL, no shine, fast					
shake response, highly calcareous				BORING NO 83-53	SAMPLE NO. 2
with shell fragments.				DEPTH ELEV 26.0-28.0	
				LABORATORY 04/34	DATE 27 DEC 1983
				TRIAXIAL COMPRESSION TEST REPORT	

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 14



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	26.0-28.0	Sandy organic, OH		207	74	133

GRADATION CURVES

Project Chaska NCS-IA-84-4-ED-GH

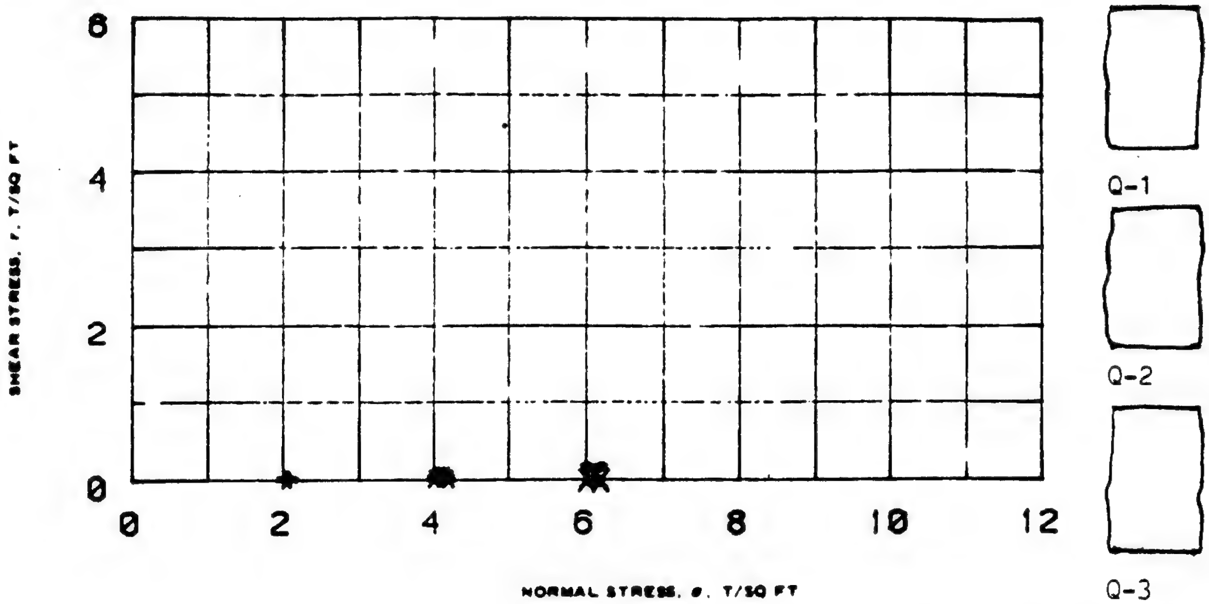
Area MRD Lab No. 84/34

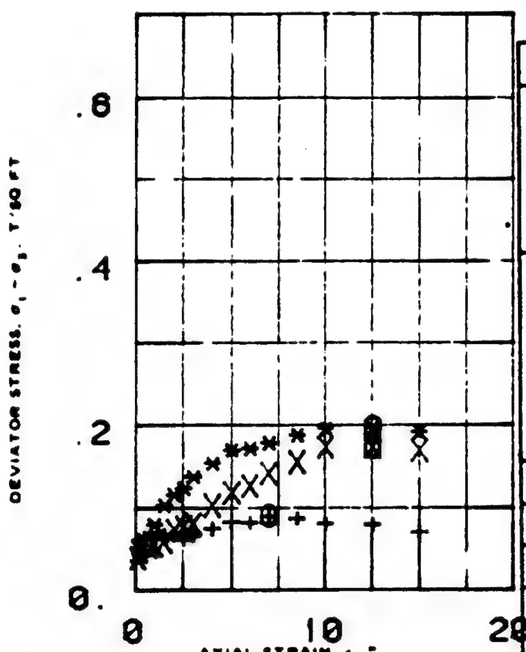
Boring No. 83-53

Date 27 DEC 1983

ENG FORM 1 MAY 63 2087

Figure 15





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	30.3	28.3	29.8	
	DRY DENSITY LB/CU FT	γd_o	88.5	95.5	92.5	
	SATURATION, %	S_o	90.	100.	98.	
	VOID RATIO	e_o	.9	.78	.82	
BEFORE SHEAR	WATER CONTENT, %	w_c	29.5	27.8	29.	
	DRY DENSITY LB/CU FT	γd_c	88.8	94.9	94.4	
	SATURATION, %	S_c	89.	98.	100.	
	VOID RATIO	e_c	.89	.77	.78	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	2.	4.	6.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.09	.197	.174	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	12	19	22	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.07	.192	.109	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.4	
INITIAL HEIGHT, IN.		H_o	2.98	2.98	2.98	

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Sandy lean clay, CL

LL 26	PL 16	PI 10	G_s 2.69	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Green to gray, soft consistency, low strength at PL, dull shine, fast shake response.

Torvane = 0.1 TSF

PROJECT CHASKA NCS-IA-84-4-ED-GH

BORING NO. 83-53 SAMPLE NO. 4

DEPTH ELEV 42.0-44.0

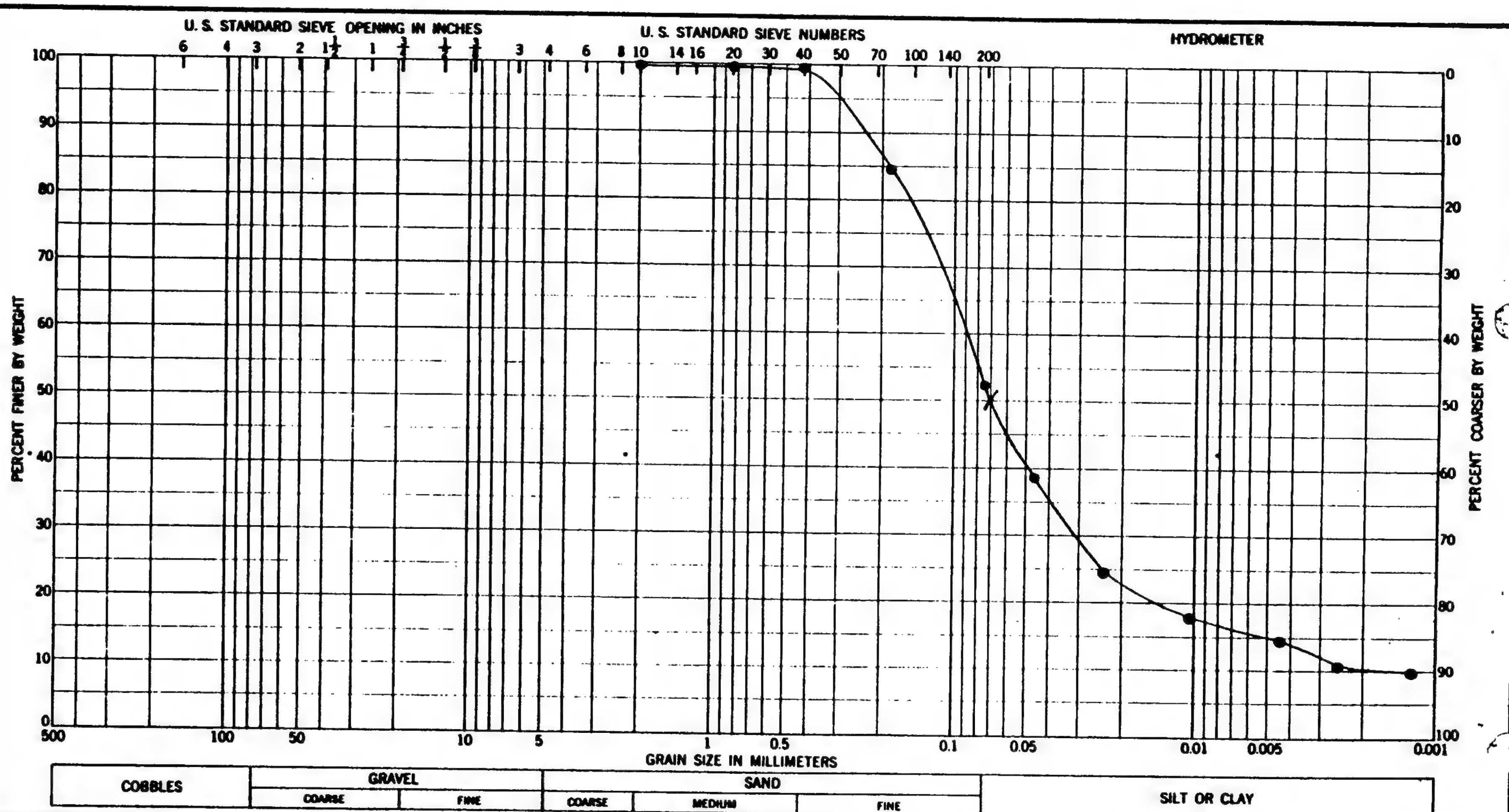
LABORATORY 84/54 DATE 07 DEC 1983

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 16

Figure C-96



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	42.0-44.0	Sandy lean clay, CL		26	16	10

Project Chaska NCS-IA-84-4-ED-GH

Area MRD Lab No. 84/34

Boring No. 83-53

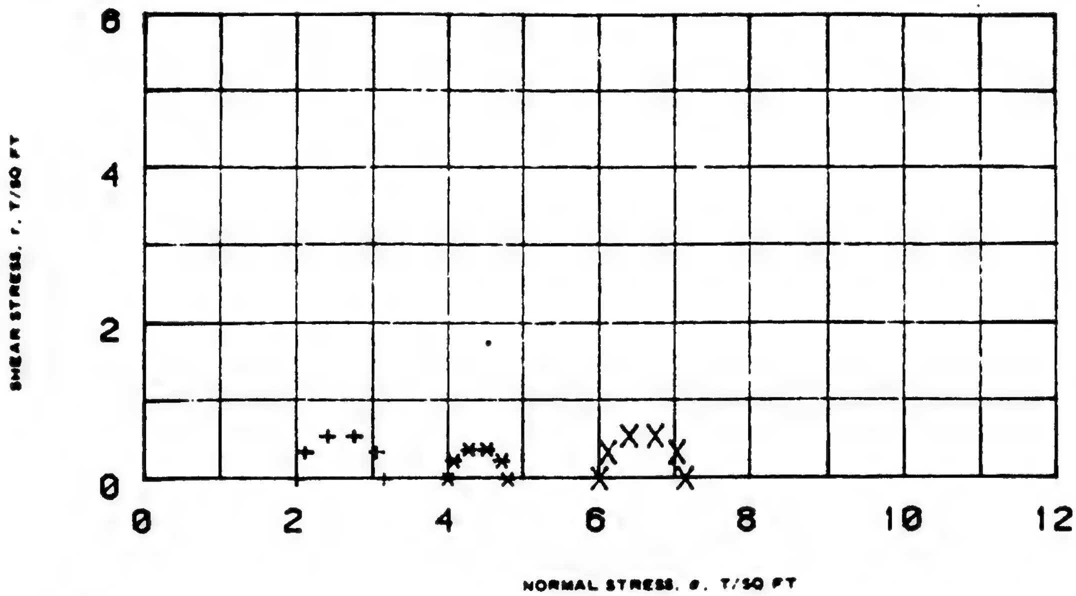
Date 27 DEC 1983

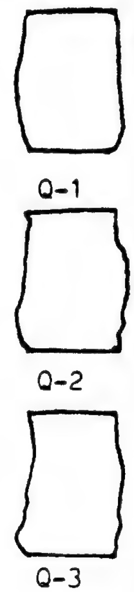
GRADATION CURVES

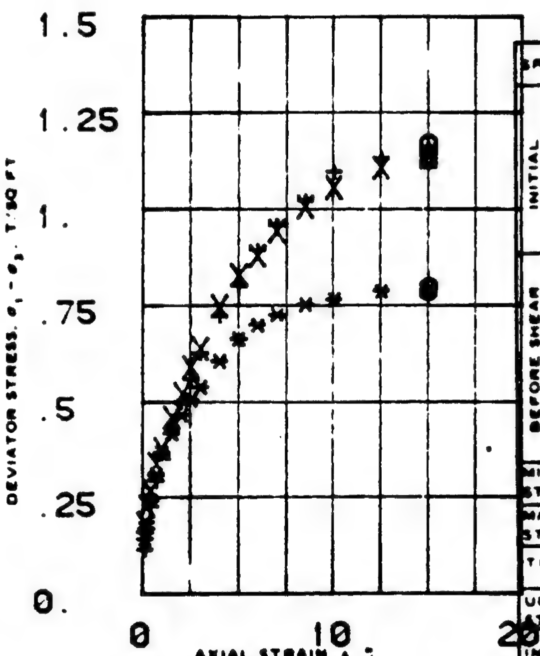
ENG FORM 1 MAY 63 2087

Figure 17

Figure C-97







SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	25.7	25.0	25.6	
	DRY DENSITY LB/CU FT	γd_o	105.7	100.5	105.4	
	SATURATION %	S_o	100.	100.	100.	
	VOID RATIO	e_o	.65	.60	.64	
BEFORE SHEAR	WATER CONTENT, %	w_c	25.7	25.7	25.5	
	DRY DENSITY LB/CU FT	γd_c	105.7	100.5	105.0	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	.65	.60	.65	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	2.	4.	6.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.16	.791	1.14	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	27	27	20	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.16	.791	1.14	
INITIAL DIAMETER, IN		D_o	1.39	1.39	1.39	
INITIAL HEIGHT, IN		H_o	3.00	3.00	3.00	

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS

LL 31	PL 15	PI 16	Gs 2.71	TYPE OF SPECIMEN UNDIST. / TYPE OF TEST Q

REMARKS: Medium to dark gray, medium consistency, medium strength at PL, gloss shine, no shake response, very slight odor.

PROJECT CHSAKA NCS-IA-04-4-ED-GH

BORING NO 83-53 SAMPLE NO. 5

DEPTH ELEV 50.0 - 51.0

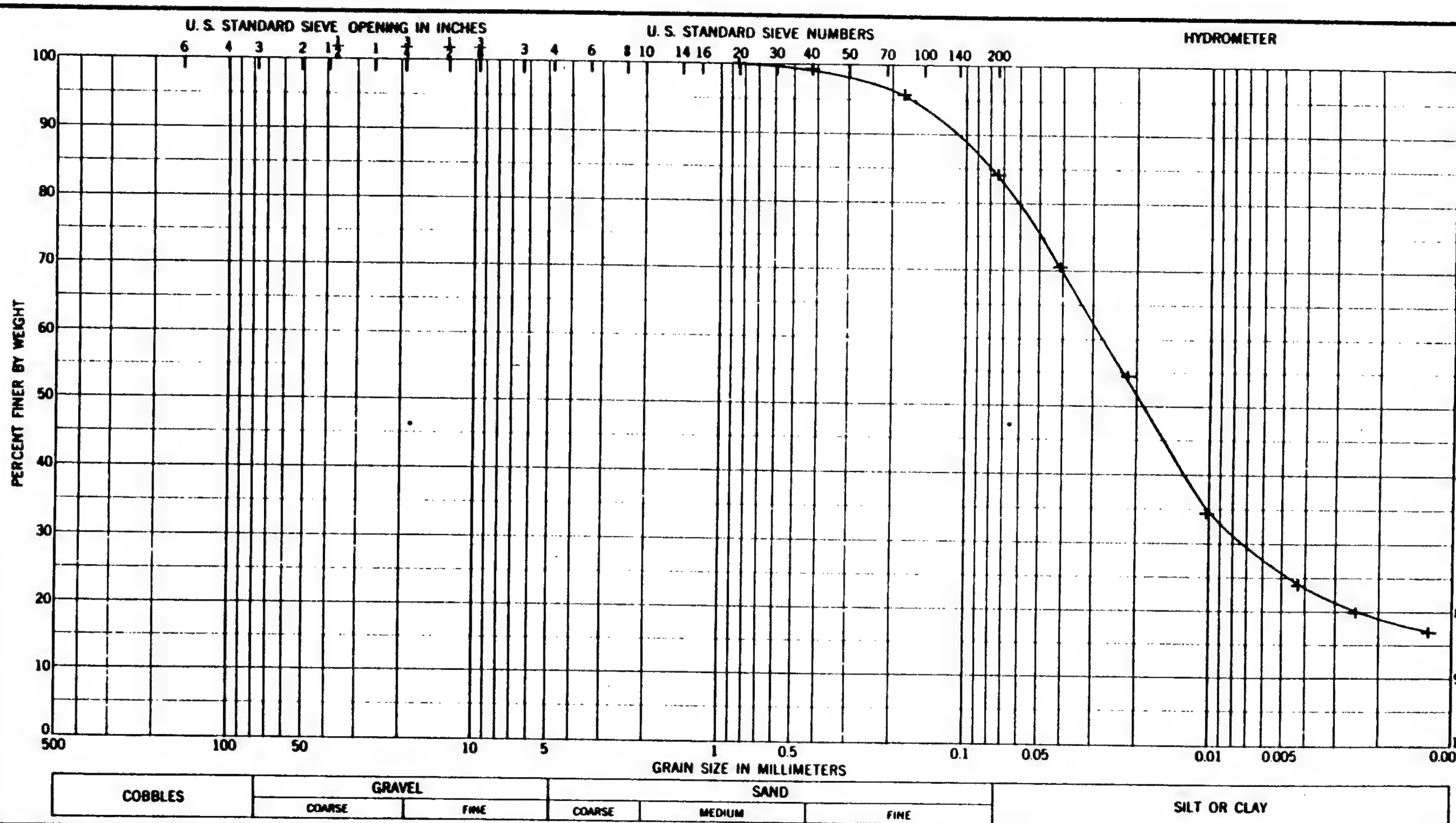
LABORATORY 04/04 DATE 11 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)*
REV JUNE 1970

Figure 2

Figure C-98



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	50.0-51.0	Lean clay, CL		31	15	16

Project CHASKA NCS-IA-84-4-ED-GH

Area MRD LAB NO. 84/34

Boring No. 83-53

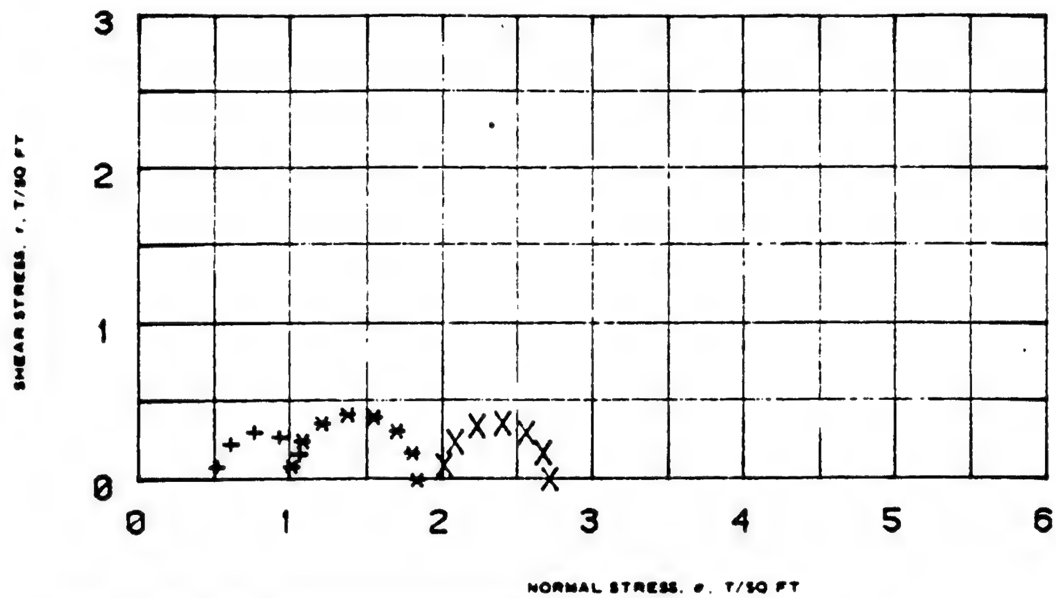
Date 11 JAN 1984

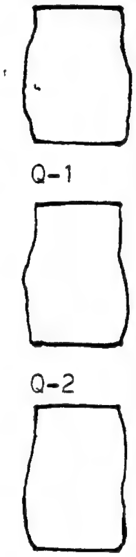
GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 3

Figure C-99

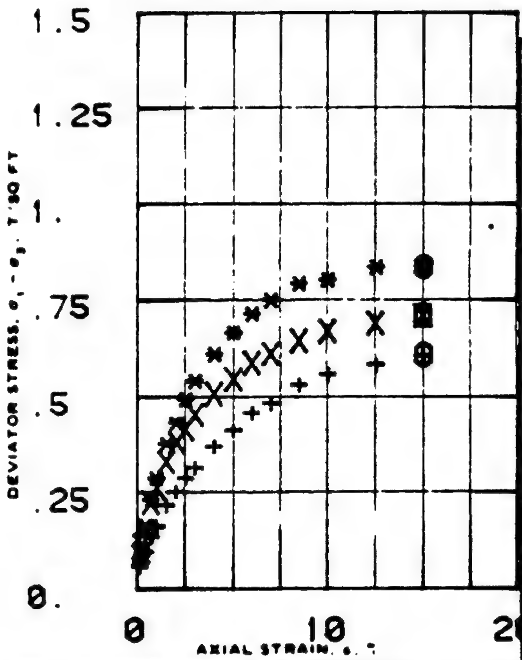




Q-1

Q-2

Q-3



SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	19.7	19.8	20.7	
	DRY DENSITY LB/CU FT	γ_{d_o}	100.9	109.5	107.8	
	SATURATION, %	S_o	99.	100.	100.	
	VOID RATIO	e_o	.53	.52	.55	
BEFORE SHEAR	WATER CONTENT, %	w_c	19.8	19.7	20.8	
	DRY DENSITY LB/CU FT	γ_{d_c}	100.9	109.5	107.8	
	SATURATION, %	S_c	98.	100.	100.	
	VOID RATIO	e_c	.53	.52	.55	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.609	.857	.71	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	20	20	20	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.609	.857	.71	
INITIAL DIAMETER, IN.		D_o	1.39	1.4	1.4	
INITIAL HEIGHT, IN.		H_o	2.99	2.99	2.99	

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Clayey sand, SC

LL 26	PL 12	PI 14	Gs 2.87	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

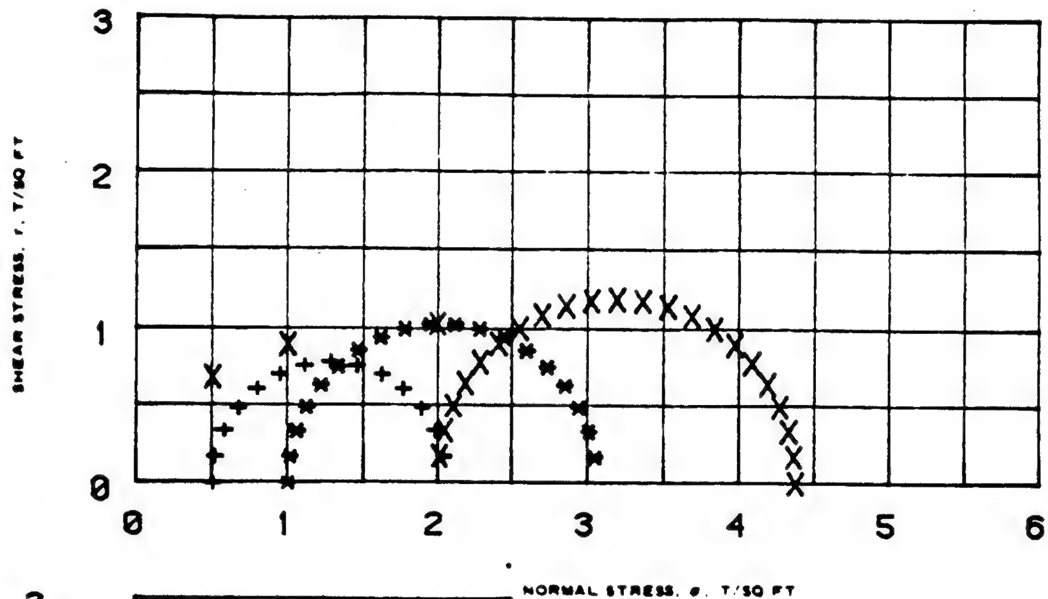
REMARKS Dark brown, medium consistency, medium strength at PL, dull shine, slow shake response, slightly calcareous.

PROJECT	CHASKA NCS-IA-84-4-ED-GH
BORING NO. 83-54	SAMPLE NO. 1
DEPTH ELEV	
LABORATORY 84/54	DATE 27 DEC 1983

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

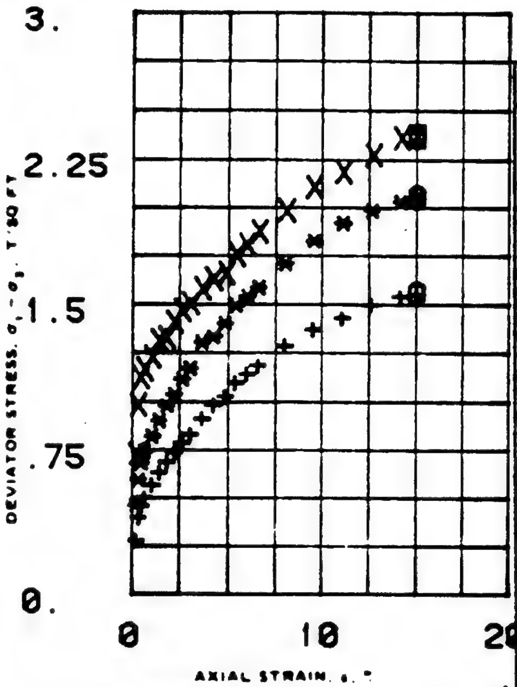
Figure 18



$\bar{R}$-1

$\bar{R}$-2

$\bar{R}$-3



SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	20.1	19.9	19.5	
	DRY DENSITY LB/CU FT	γd_o	109.	108.5	107.7	
	SATURATION %	S_o	100.	99.	96.	
	VOID RATIO	e_o	.53	.54	.55	
BEFORE SHEAR	WATER CONTENT, %	w_c	19.0	19.2	18.9	
	DRY DENSITY LB/CU FT	γd_c	109.4	110.2	110.0	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	.52	.51	.5	
	FINAL BACK PRESSURE T/SQ FT	u_o	2.08	2.06	2.06	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.56	2.06	2.37	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1271	1207	1203	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.50	2.06	2.37	
INITIAL DIAMETER, IN		D_o	1.41	1.41	1.39	
INITIAL HEIGHT, IN		H_o	2.99	2.99	2.99	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS B value = 1.00 0.98 1.00

Clayey sand, SC

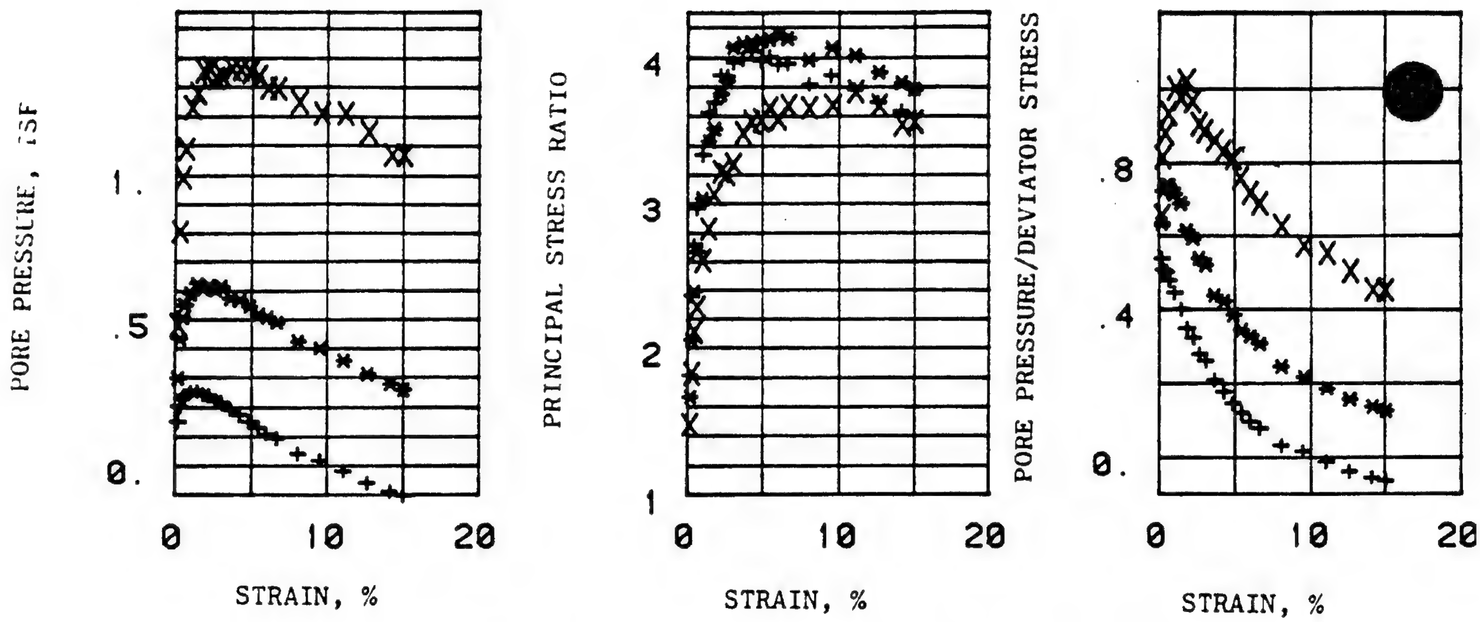
LL 26	PL 12	PI 14	G_s 2.67	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST $\bar{R}$

REMARKS	PROJECT CHASKA NCS-IA-84-4-ED-BH
	BORING NO 85-54 — SAMPLE NO. 1
	DEPTH ELEV .
	LABORATORY 84/54 — DATE 27 DEC 1983
	TRIAXIAL COMPRESSION TEST REPORT

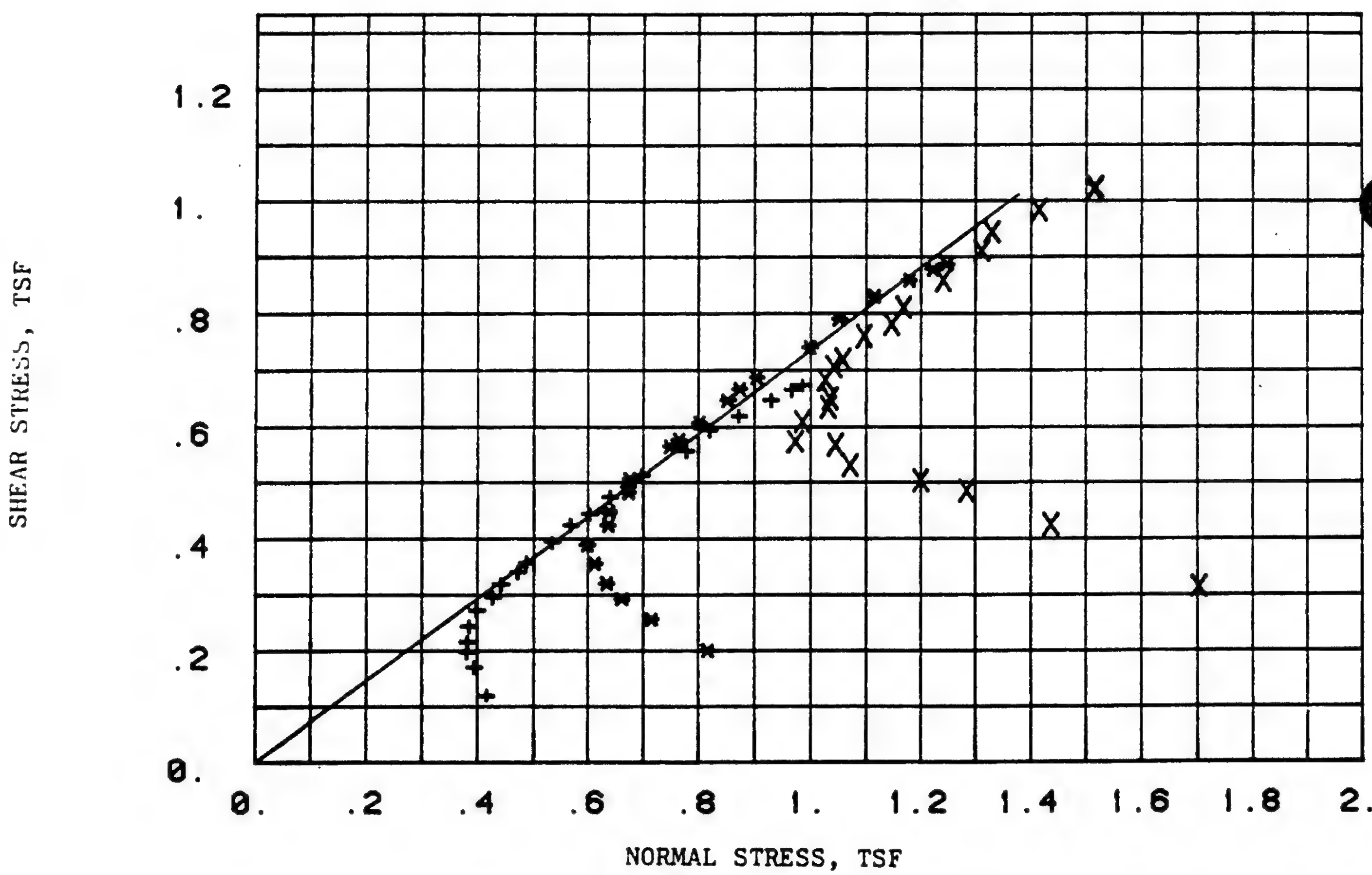
ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 19

Figure C-101



EFFECTIVE STRESS VECTOR CURVES ON 60. DEGREE PLANE



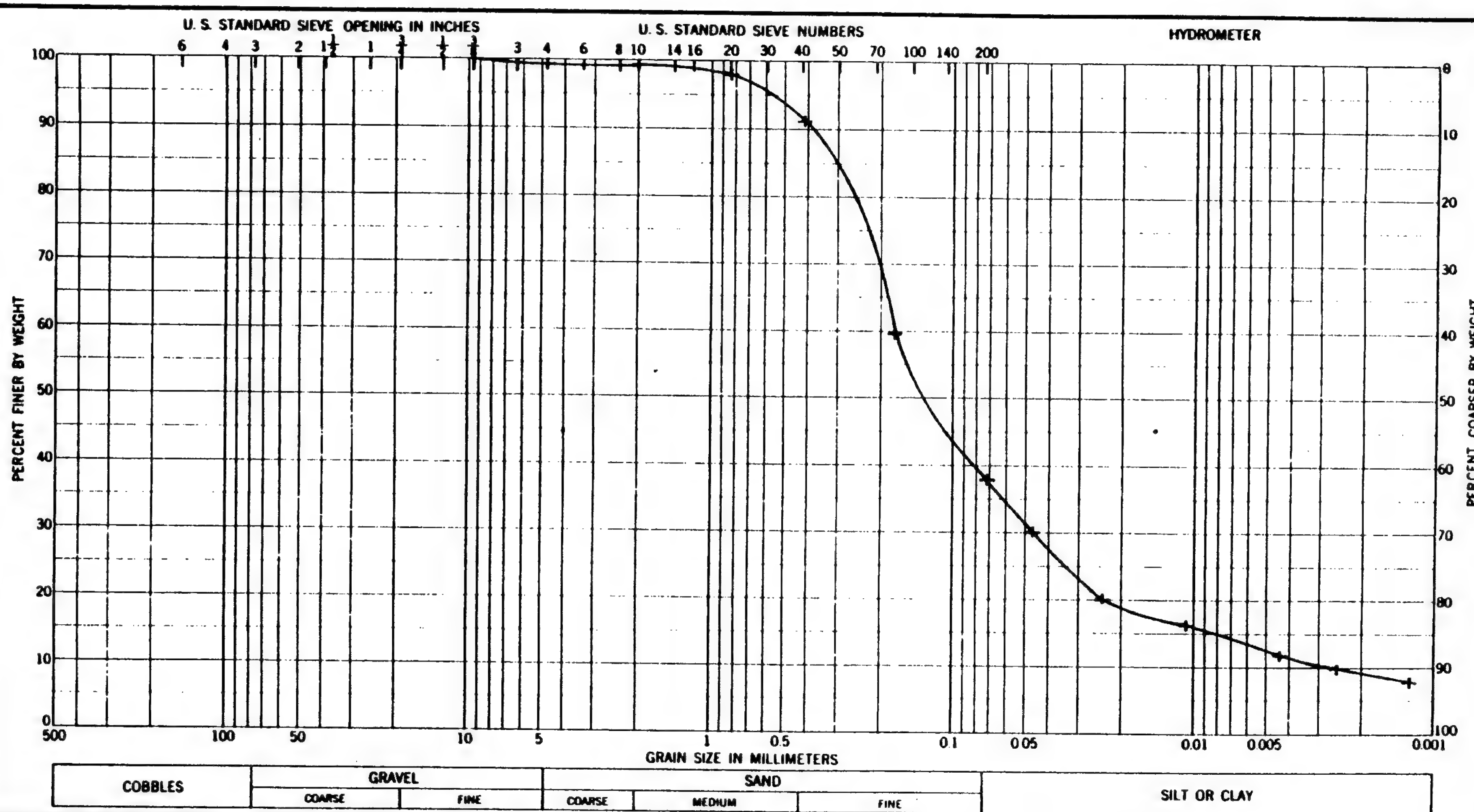
REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R̄ TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

PROJECT: CHASKA NCS-IA-84-4-ED-GH
BORING NO: 83-54 SAMPLE NO: 1
DEPTH/ELEV:
MRD LAB NO: 84/54 DATE: 27 DEC 1983

TRIAXIAL COMPRESSION TEST REPORT

MRD Form 756, 1 May 80

FIGURE: 20



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	•	Clayey sand, SC		26	12	14

GRADATION CURVES

Project CHASKA NCS-IA-84-4-ED-GH

Area MRD LAB NO. 83/54

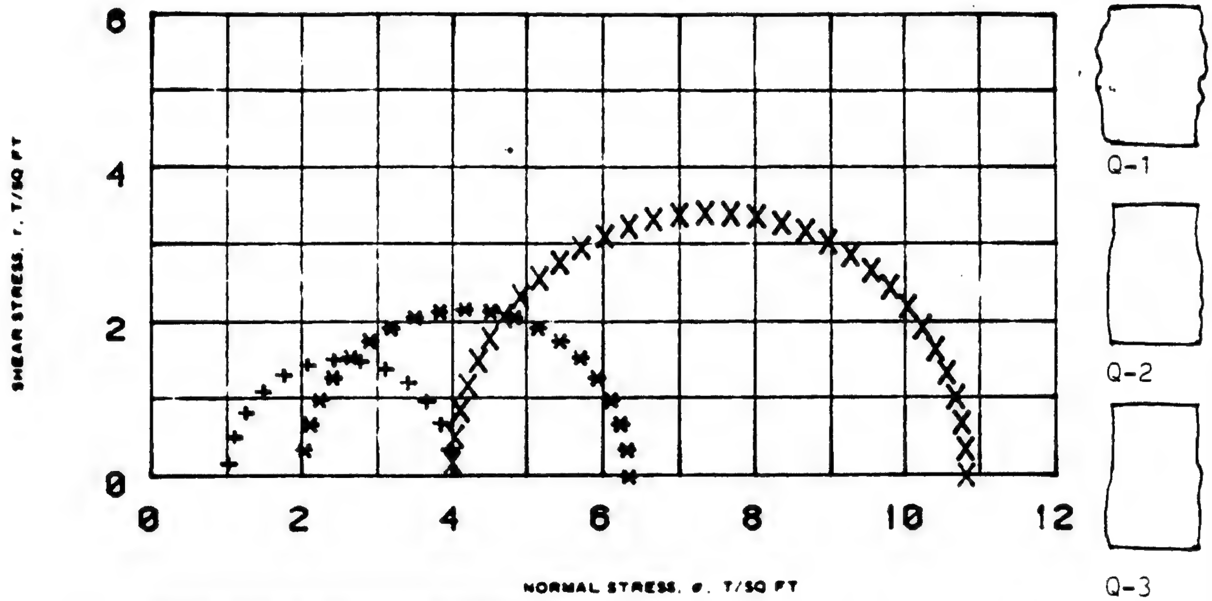
Boring No. 83-54

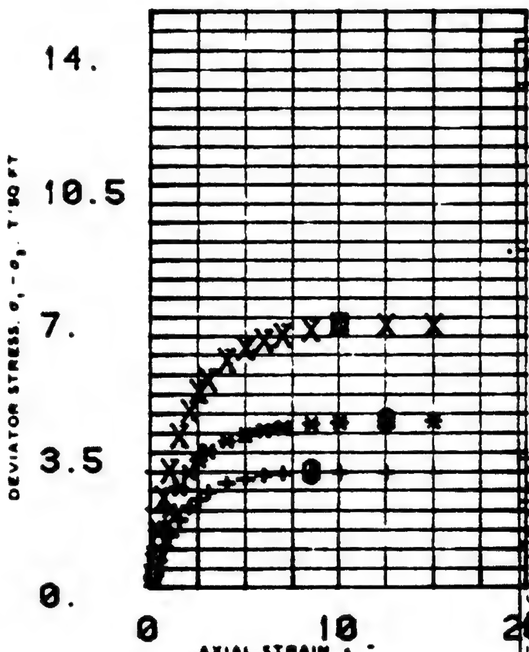
Date 27 DEC 1983

ENG FORM 1 MAY 63 2087

FIGURE 21

Figure C-103





			1	2	3	
SPECIMEN NO			1	2	3	
INITIAL	WATER CONTENT, %	w_o	13.5	14.	13.3	
INITIAL	DRY DENSITY LB/CU FT	γd_o	115.7	112.2	112.9	
INITIAL	SATURATION, %	S_o	78.	78.	75.	
INITIAL	VOID RATIO	e_o	.43	.40	.47	
BEFORE SHEAR	WATER CONTENT, %	w_c	13.4	13.9	13.2	
BEFORE SHEAR	DRY DENSITY LB/CU FT	γd_c	114.0	113.7	115.0	
BEFORE SHEAR	SATURATION, %	S_c	80.	80.	81.	
BEFORE SHEAR	VOID RATIO	e_c	.45	.48	.43	
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	3.01	4.33	6.82	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	15	24	25	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	3.	4.32	6.79	
INITIAL DIAMETER IN		D_o	1.41	1.4	1.41	
INITIAL HEIGHT IN		H_o	2.96	2.98	2.98	

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Clayey sand, SC

LL 32	PL 13	PI 19	G_s 2.68	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Mottled brown, stiff consistency, low strength at PL, medium shake response, highly calcareous.

PROJECT CHASKA NCS-IA-84-4-ED-GH

BORING NO 83-55 | SAMPLE NO. 1

DEPTH ELEV ~~10.5-17.7~~ 7.0 - 8.5

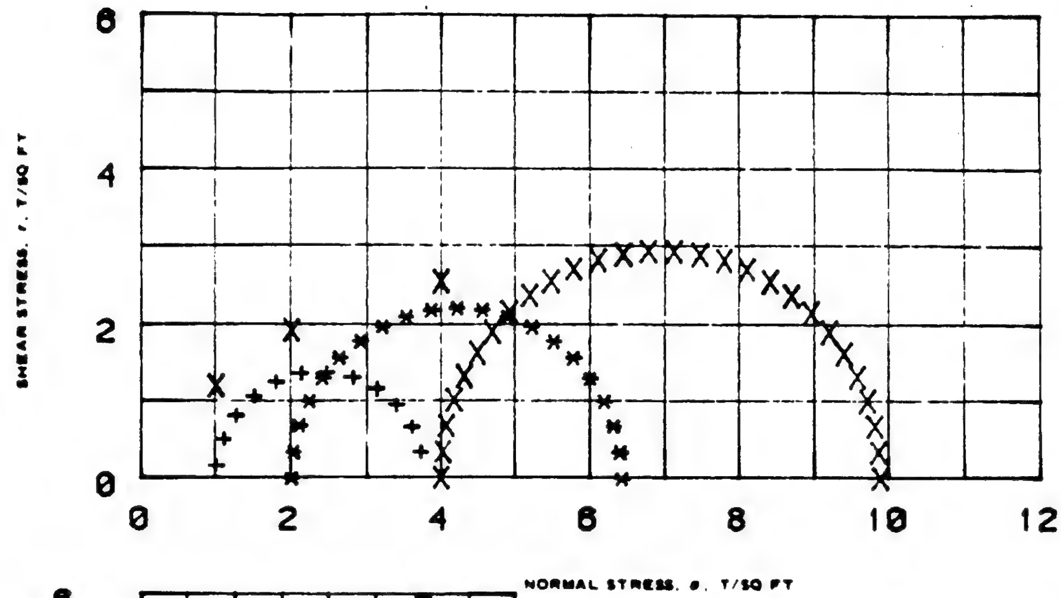
LABORATORY 84/54 | DATE 27 DEC 1983

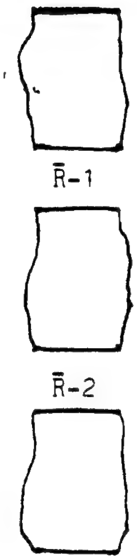
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)*

Figure 22

Figure C-104

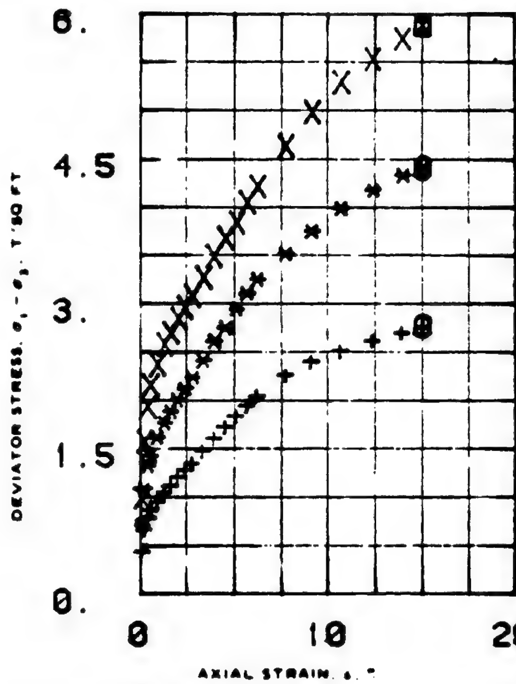




$\bar{R}$-1

$\bar{R}$-2

$\bar{R}$-3



SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	12.2	13.	12.5	
	DRY DENSITY LB/CU FT	γd_o	110.0	110.5	110.3	
	SATURATION, %	S_o	81.	88.	78.	
	VOID RATIO	e_o	.4	.4	.43	
BEFORE SHEAR	WATER CONTENT, %	w_c	14.5	14.4	13.8	
	DRY DENSITY LB/CU FT	γd_c	121.9	125.	122.9	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	.38	.35	.35	
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.54	5.54	5.54	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	2.77	4.42	5.89	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1287	1281	1279	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	2.77	4.42	5.89	
INITIAL DIAMETER IN		D_o	1.4	1.4	1.41	
INITIAL HEIGHT, IN		H_o	2.99	2.99	3.	

CONTROLLED- STRAIN TEST

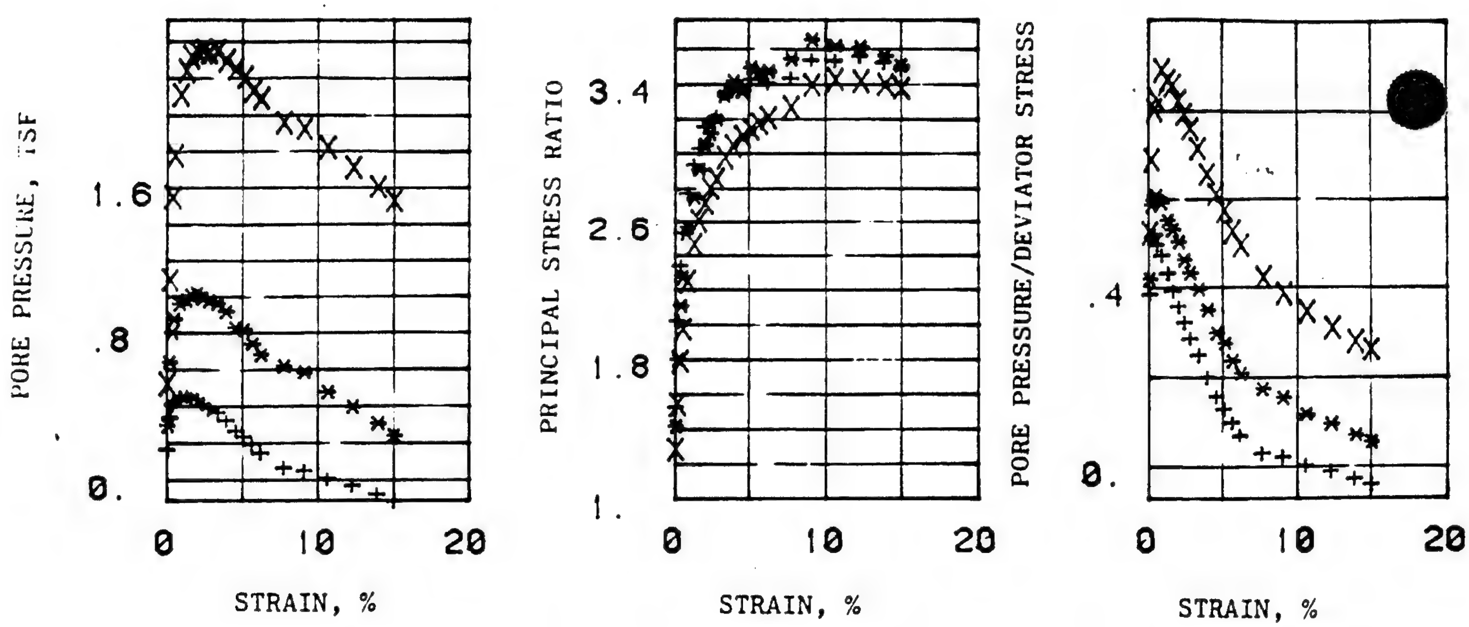
DESCRIPTION OF SPECIMENS Clayey sand, SC B value 1.00 1.00 0.99

LL 32	PL 13	PI 19	Gs 2.68	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST $\bar{R}$
REMARKS				PROJECT CHASKA NCS-IA-84-4-ED-8H	
				BORING NO 83-55	SAMPLE NO. 1
				DEPTH ELEV 7.0-8.5	
				LABORATORY 84/84	DATE 10 JAN 1984
				TRIAXIAL COMPRESSION TEST REPORT	

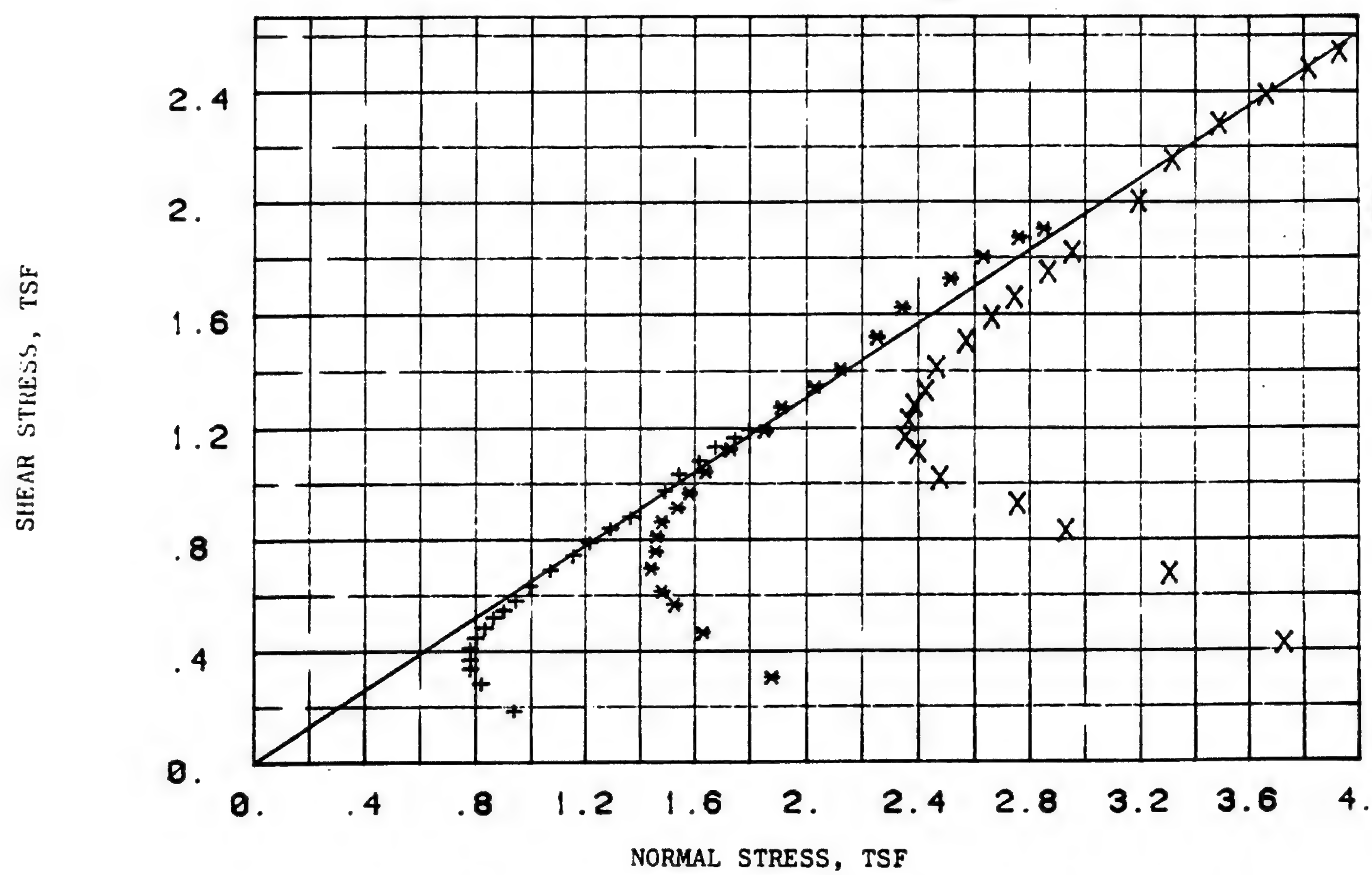
ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)*

Figure 5

Figure C-105



EFFECTIVE STRESS VECTOR CURVES ON 60. DEGREE PLANE



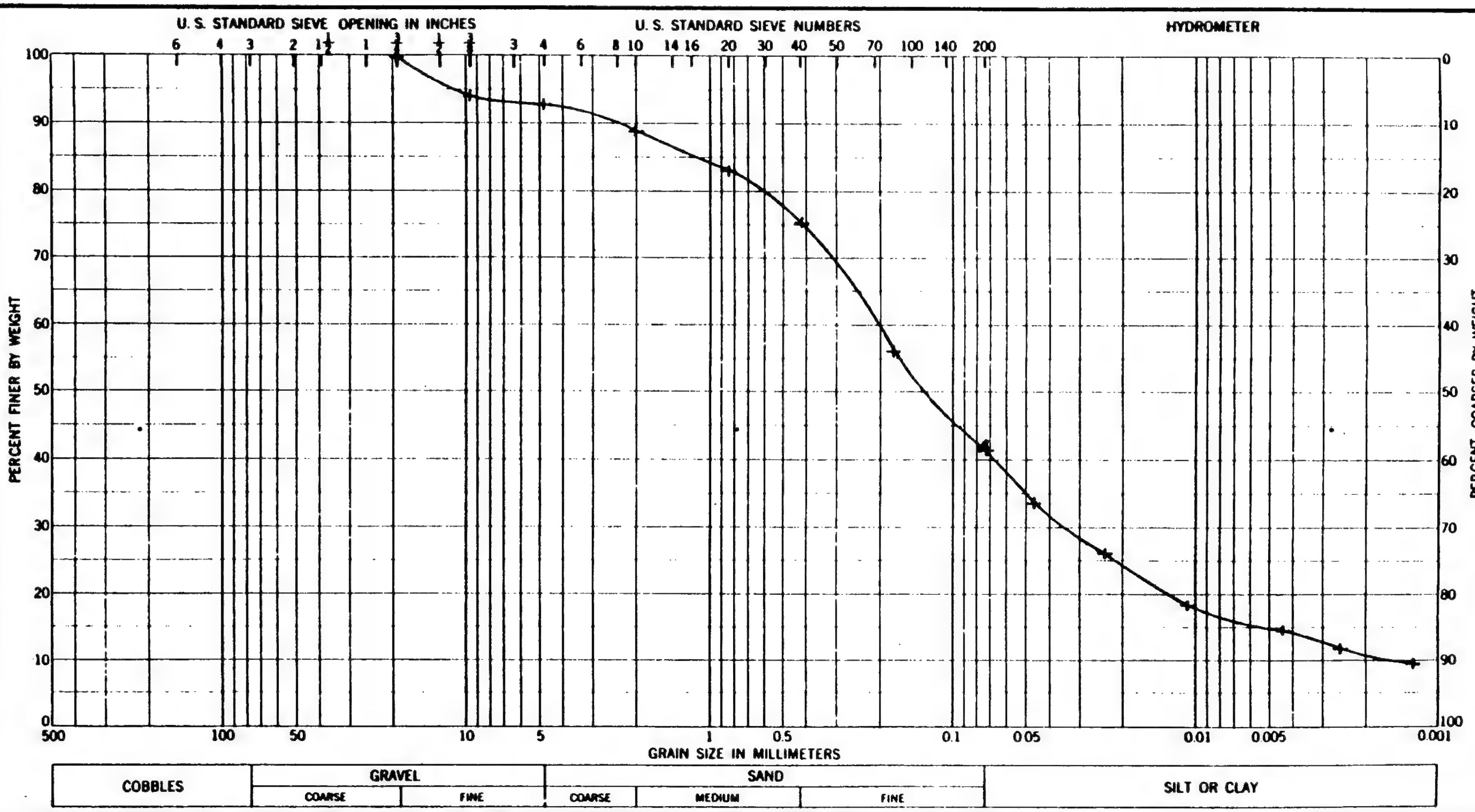
REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

PROJECT:	CHASKA NCS-IA-84-4-ED-GH
BORING NO:	83-56
SAMPLE NO:	1
DEPTH/ELEV:	7.0-8.5
MRD LAB NO:	84/54
DATE:	10 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 6

MRD Form 756, 1 May 80



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	16.5-17.7	Clayey sand, SC		32	13	19

Project CHASKA NCS-IA-84-4-ED-GH

Area MRD LAB NO. 84/34

Boring No. 83-55

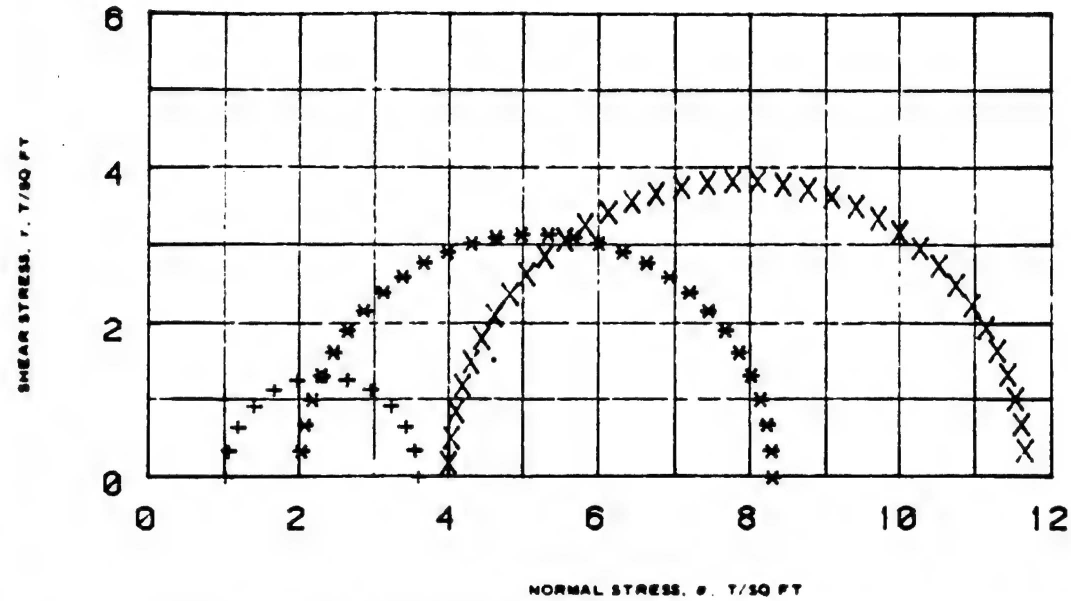
Date 27 DEC 1983

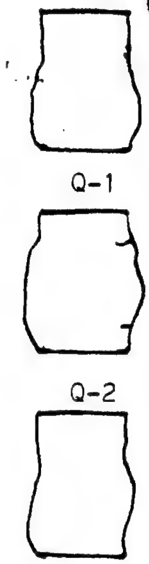
GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 23

Figure C-107

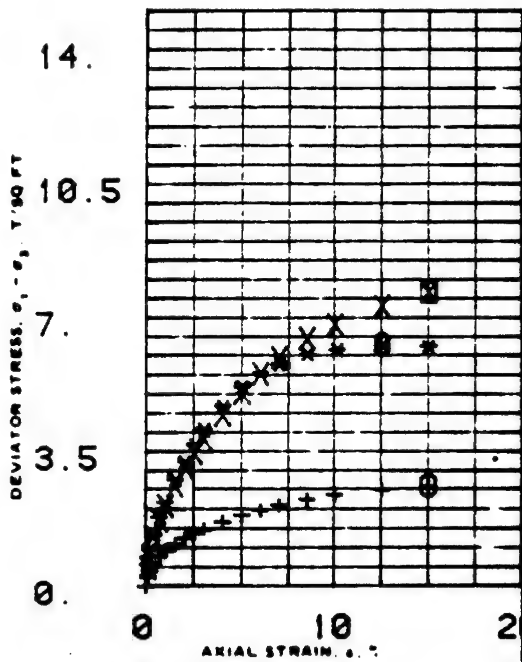




Q-1

Q-2

Q-3



SPECIMEN NO			1	2	3	
INITIAL	WATER CONTENT, %	w_o	12.7	11.8	11.4	
	DRY DENSITY LB/CU FT	γ_{d_o}	121.9	126.7	127.1	
	SATURATION, %	S_o	89.	94.	94.	
	VOID RATIO	e_o	.39	.34	.33	
BEFORE SHEAR	WATER CONTENT, %	w_c	12.8	11.5	11.4	
	DRY DENSITY LB/CU FT	γ_{d_c}	121.9	128.7	127.6	
	SATURATION, %	S_c	88.	93.	95.	
	VOID RATIO	e_c	.39	.34	.33	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{max}$		2.6	6.8	7.67	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	38	27	32	
ULTIMATE DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{ult}$		2.8	6.28	7.67	
INITIAL DIAMETER, IN.		D_o	1.41	1.4	1.41	
INITIAL HEIGHT, IN.		H_o	3.00	3.00	3.00	

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Gravelly clayey sand, SC

LL 19	PL 11	PI 8	G_s 2.71	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Mottled browns, stiff consistency, low strength at PL, dull shine, medium shake response, highly calcareous, pockets of silt. All 3 specimens required approximately 30% patching.

PROJECT CHASKA NCS-IA-84-4-ED-GH

BORING NO. 83-55 SAMPLE NO. 2

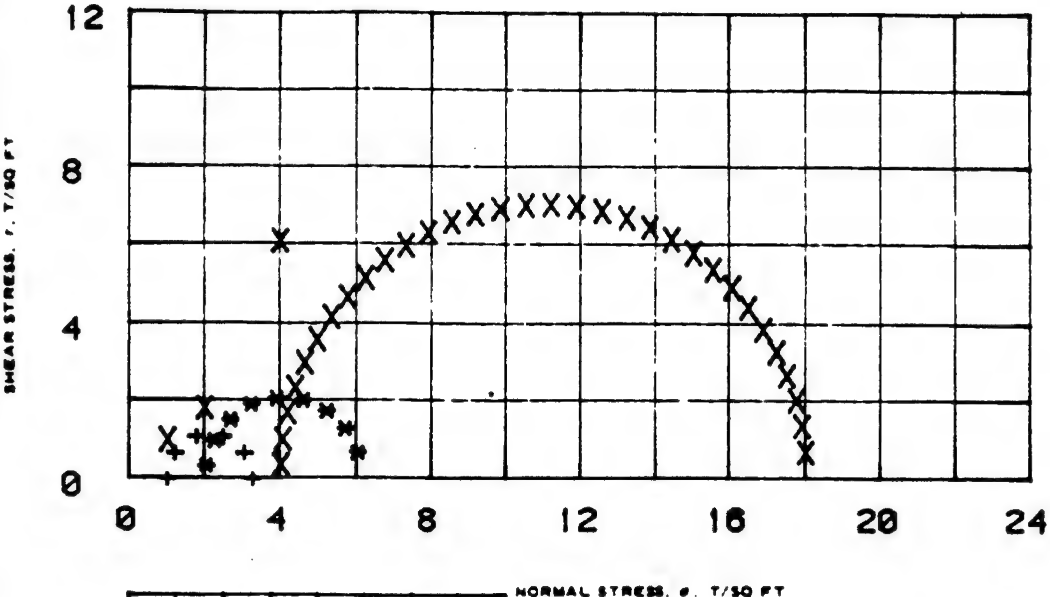
DEPTH ELEV 16.5-17.7

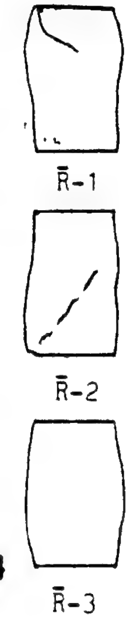
LABORATORY 84/84 DATE 11 JAN 1984

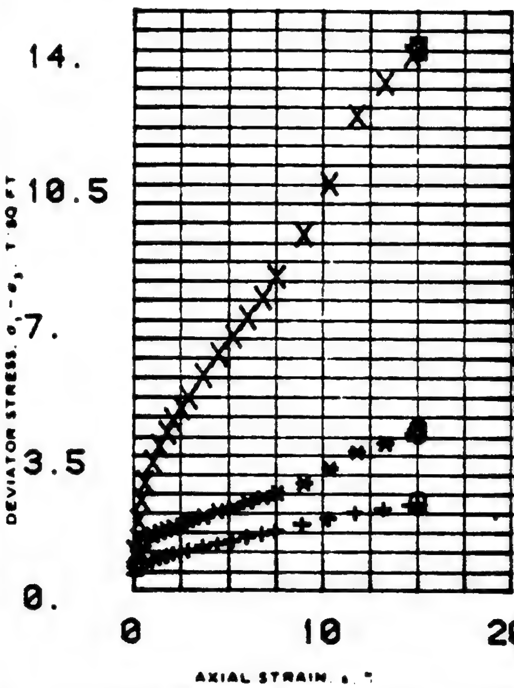
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 4







SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	15.9	15.	18.7	
	DRY DENSITY LB/CU FT	γ_{d_o}	115.6	116.8	115.	
	SATURATION, %	S_o	95.	91.	98.	
	VOID RATIO	e_o	.48	.45	.47	
BEFORE SHEAR	WATER CONTENT, %	w_c	18.5	14.9	18.	
	DRY DENSITY LB/CU FT	γ_{d_c}	118.0	120.5	117.9	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	.45	.4	.45	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.0	4.02	4.02	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	2.27	4.16	14.1	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1252	1221	1224	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	2.27	4.16	14.1	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.4	
INITIAL HEIGHT, IN.		H_o	2.99	2.98	2.98	

CONTROLLED- STRAIN TEST

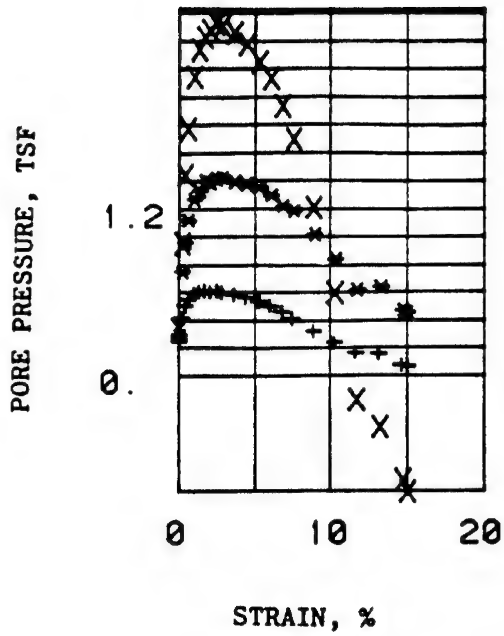
DESCRIPTION OF SPECIMENS Gravelly clayey sand, SC

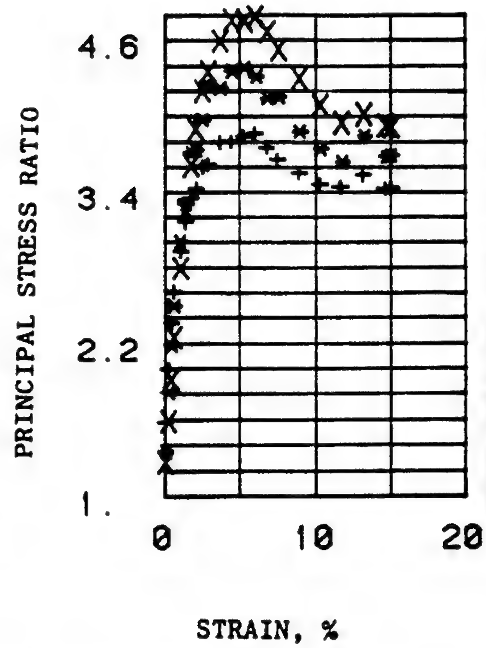
LL 19	PL 11	PI 8	Gs 2.71	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST R̄

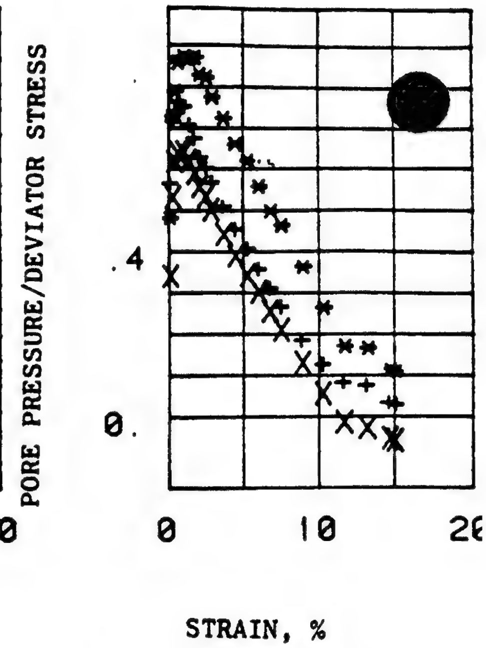
REMARKS Due to gravel in material, specimens R̄-1 and R̄-2 required considerable patching. Specimen R̄-3 required less patching.	PROJECT CHAGKA NCS-IA-84-4-ED-GH	
	BORING NO. 85-55MN	SAMPLE NO. 2
	DEPTH/ELEV 16.6-17.7	
	LABORATORY 84/64	DATE 11 JAN 1984
	TRIAXIAL COMPRESSION TEST REPORT	

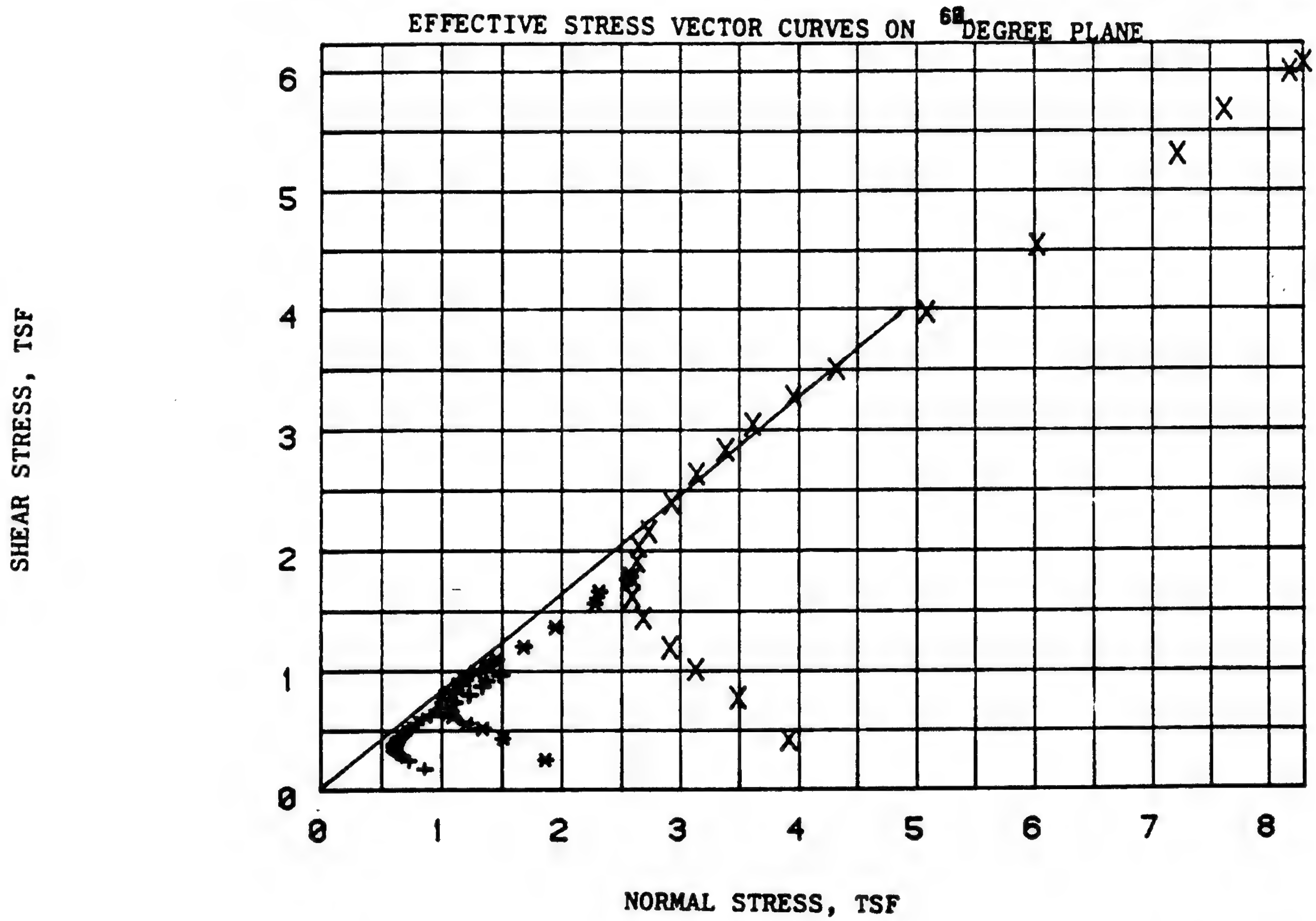
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 5









REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

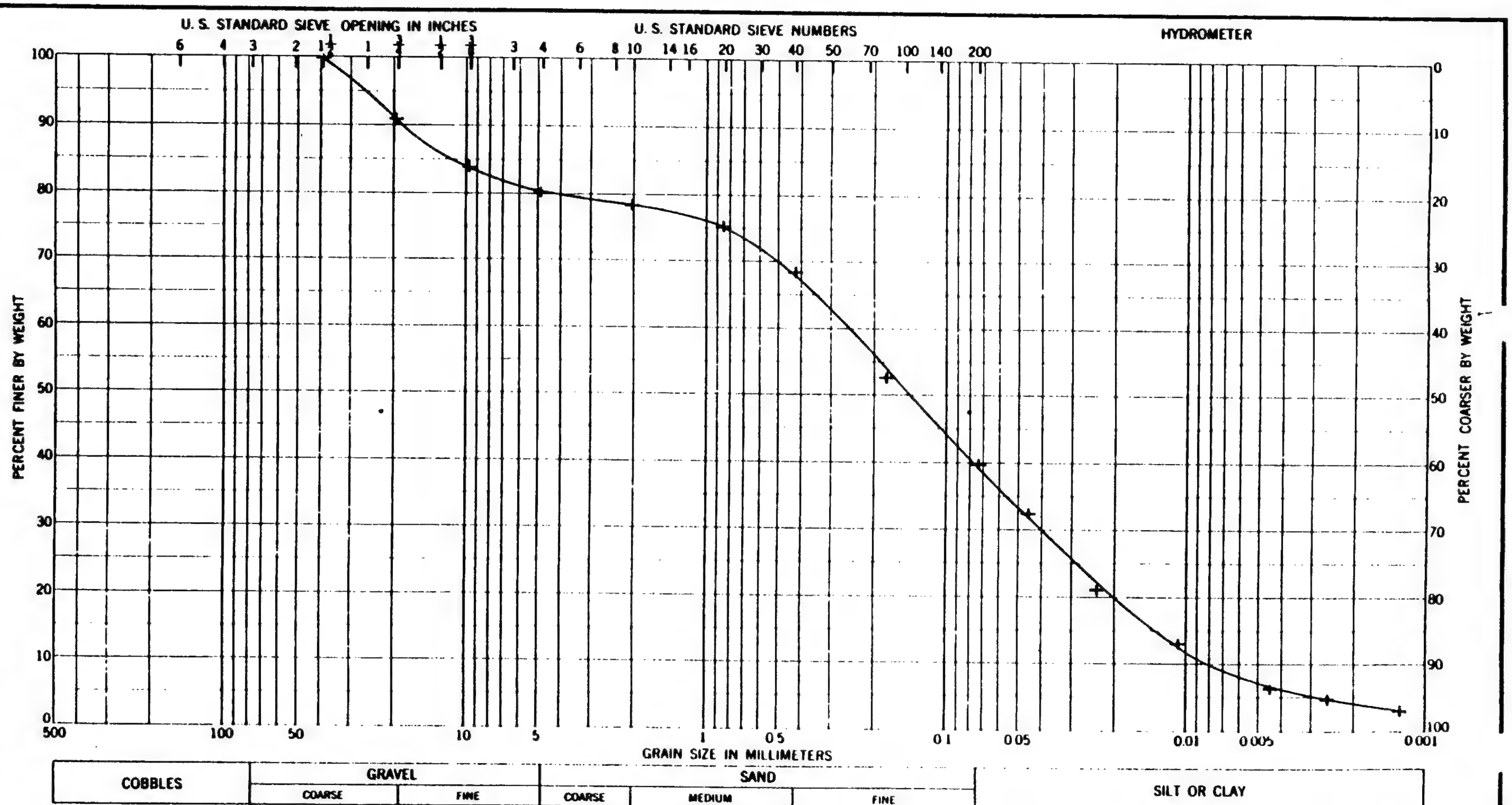
MRD Form 756, 1 May 80

PROJECT: CHASKA NCS-IA-84-4-ED-GH
BORING NO: 83-56MN SAMPLE NO: 2
DEPTH/ELEV: 16.5-17.7
MRD LAB NO: 84/54 DATE: 11 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 6

Figure C-110



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	16.5-17.7	Gravelly clayey sand, SC		19	11	8

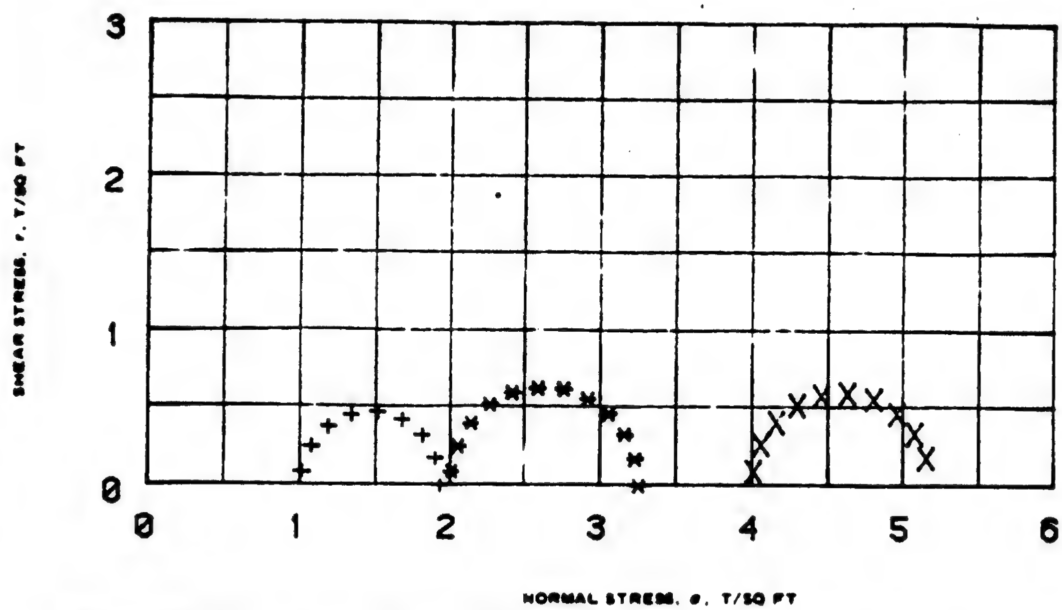
Project	CHASKA NCS-IA-84-4-ED-GH
Area	MRD LAB NO. 84/34
Boring No.	83-55
Date	11 JAN 1984

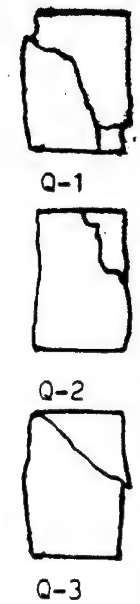
GRADATION CURVES

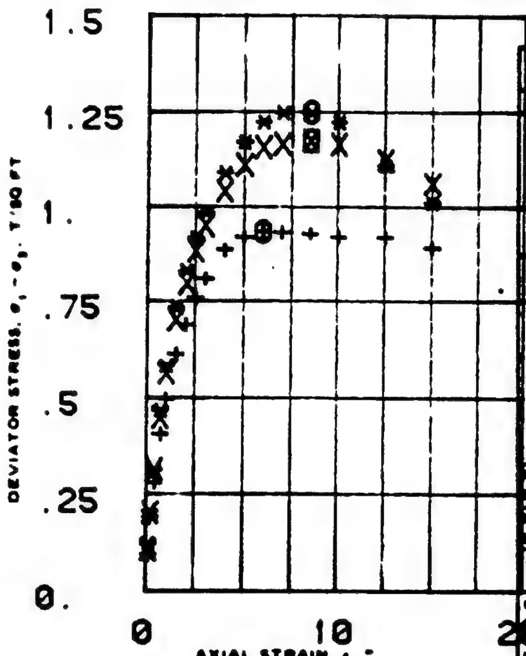
ENG FORM 1 MAY 63 2087

FIGURE 7

Figure C-111







SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	85.4	84.	85.4	
	DRY DENSITY LB/CU FT	γ_{d_o}	50.7	50.2	50.7	
	SATURATION, %	S_o	100.	99.	100.	
	VOID RATIO	e_o	2.15	2.16	2.15	
BEFORE SHEAR	WATER CONTENT, %	w_c	85.5	85.0	85.4	
	DRY DENSITY LB/CU FT	γ_{d_c}	50.7	50.4	50.4	
	SATURATION, %	S_c	99.	99.	99.	
	VOID RATIO	e_c	2.15	2.16	2.16	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.934	1.25	1.10	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	10	15	15	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.892	1.01	1.06	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.41	
INITIAL HEIGHT, IN.		H_o	2.98	2.97	2.96	

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Fat clay, CH (Considerable organic)

LL 135	PL 39	PI 96	Gs 2.54	TYPE OF SPECIMEN UNDIST	TYPE OF TEST Q

REMARKS: Dark gray, medium consistency, medium strength at PL, dull shine no shake response.

PROJECT CHASKA NCS-1A-84-4-ED-GH

BORING NO 83-58 — SAMPLE NO. 1

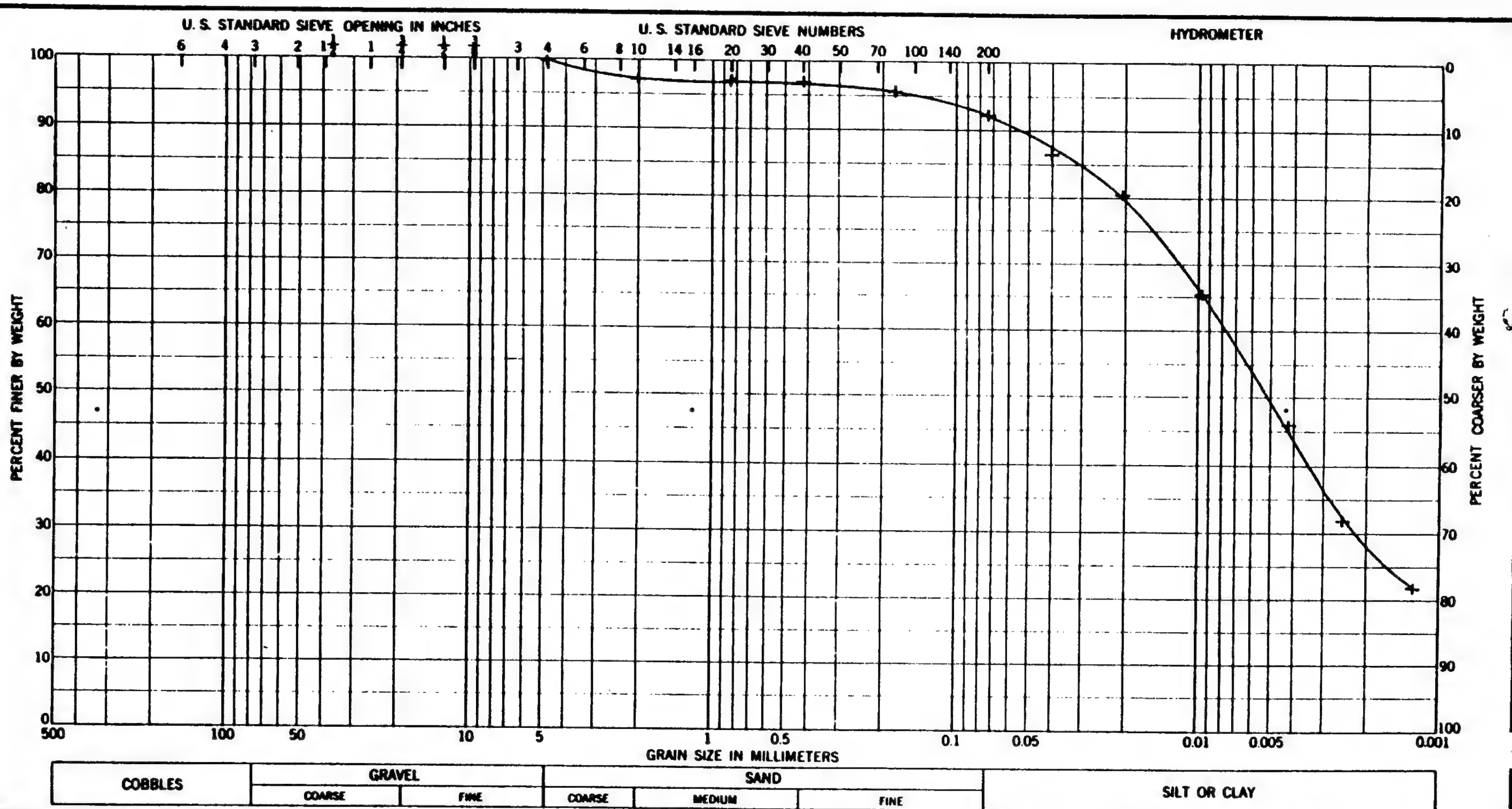
DEPTH ELEV 27.0-29.0

LABORATORY 84/54 — DATE 11 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 — PREVIOUS EDITION IS OBSOLETE — TRANSLUCENT (EM 1110-2-1906)

Figure 8



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	27.0-29.0	Fat clay, CH (Possibly organic)		135	39	96

Project: CHASKA NCS-IA-84-4-ED-GH

Area: MRD LAB NO. 84/34

Boring No.: 83-58

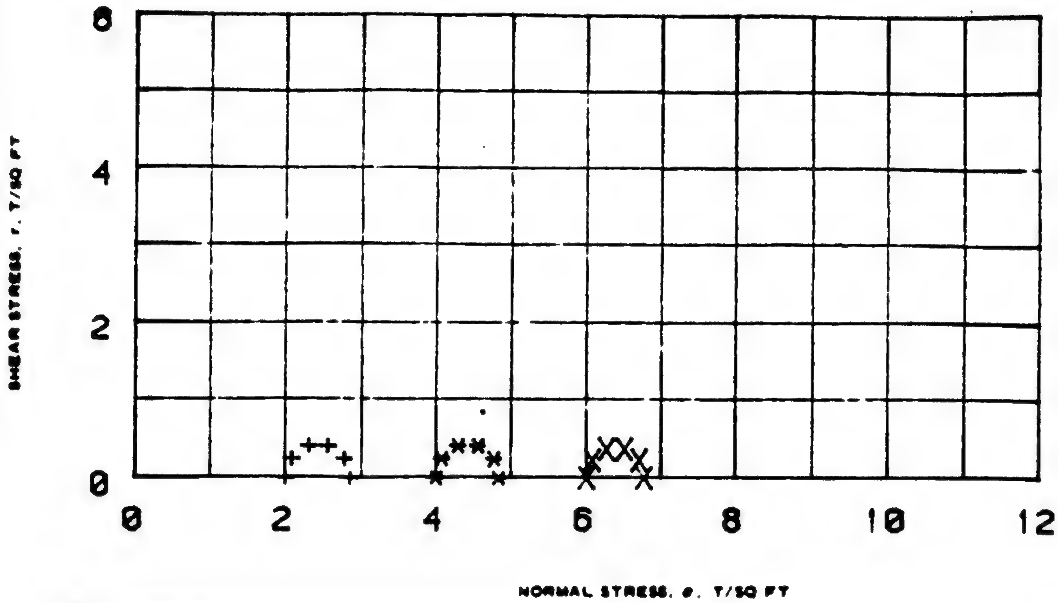
Date: 11 JAN 1984

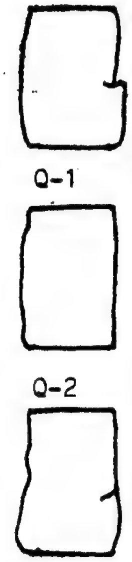
GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 9

Figure C-113

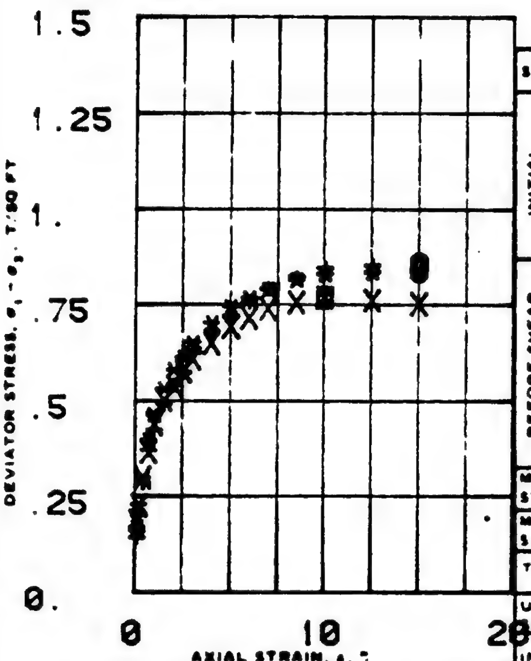




Q-1

Q-2

Q-3



SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	34.5	37.7	38.7	
	DRY DENSITY LB/CU FT	γd_o	87.7	85.5	82.6	
	SATURATION, %	S_o	100.	100.	100.	
	VOID RATIO	e_o	.89	.99	1.01	
BEFORE SHEAR	WATER CONTENT, %	w_c	34.4	37.7	38.6	
	DRY DENSITY LB/CU FT	γd_c	87.7	85.7	85.1	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	.89	.98	1.	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	2.	4.	6.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.865	.841	.769	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	27	27	10	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.865	.841	.755	
INITIAL DIAMETER, IN.		D_o	1.39	1.39	1.39	
INITIAL HEIGHT, IN.		H_o	3.00	3.00	3.01	

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Fat clay, CH

LL 64	PL 19	PI 45	G_s 2.[illegible]	TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	Q

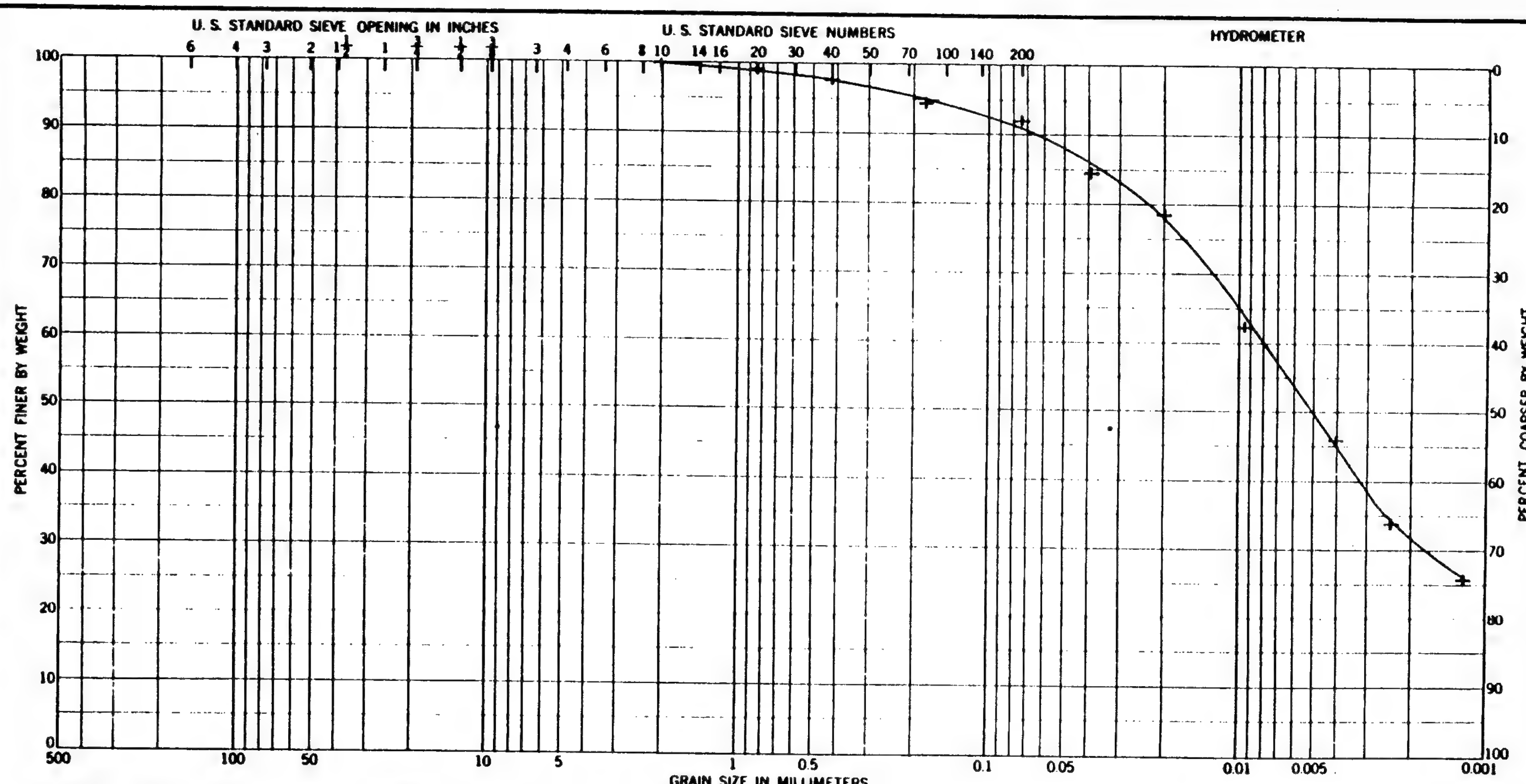
REMARKS: Dark gray, medium consistency, medium strength at PL, gloss shine, no shake response, slightly calcareous.

PROJECT	CHASKA NCS-IA-04-4-ED-GH
BORING NO 83-58	SAMPLE NO. 2
DEPTH ELEV	39.0,41.0
LABORATORY 04-34	DATE 11 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	39.0-41.0	Fat clay, CH		64	19	45

Project CHASKA NCS-IA-84-4-ED-GH

Area MRD LAB NO. 84/34

Boring No. 83-58

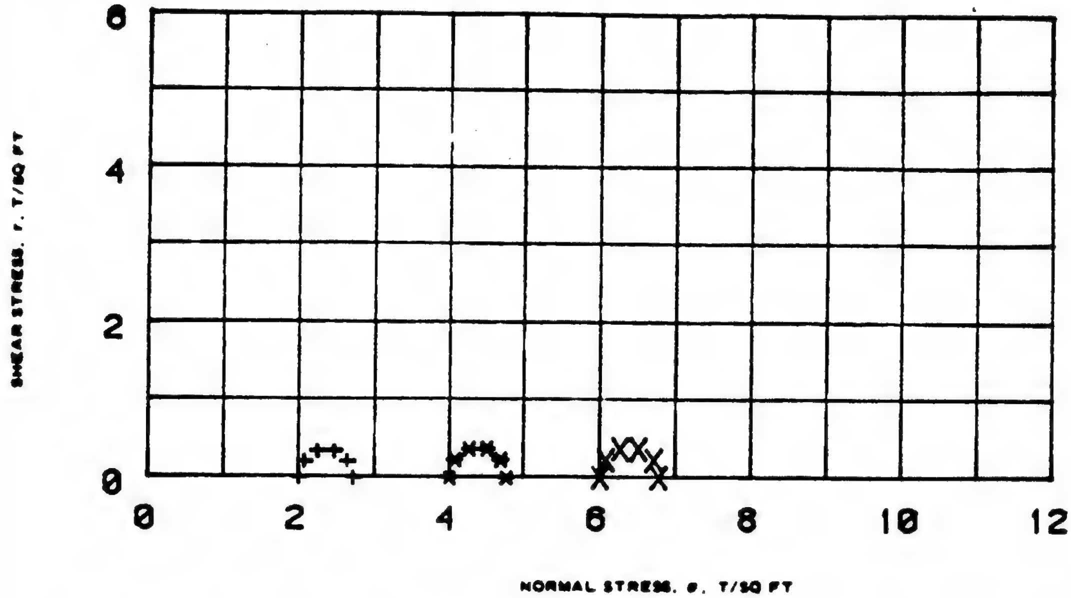
Date 11 JAN 1984

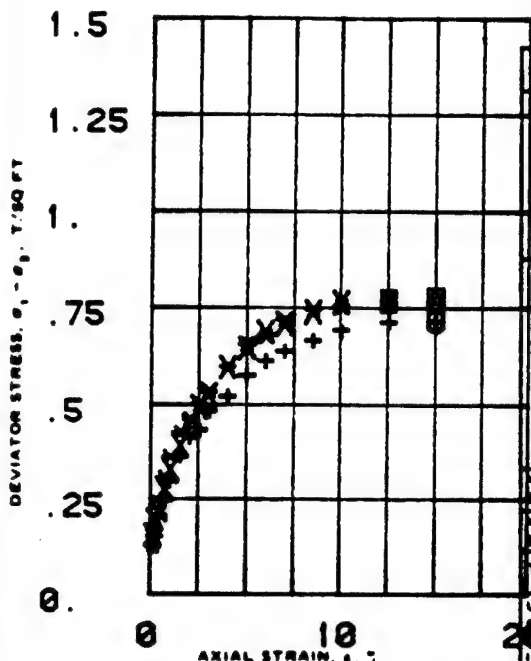
GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 11

Figure C-115





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	33.8	33.5	32.5	
	DRY DENSITY LB/CU FT	γd_o	89.1	89.5	90.4	
	SATURATION, %	S_o	100.	100.	100.	
	VOID RATIO	e_o	.9	.9	.87	
BEFORE SHEAR	WATER CONTENT, %	w_c	33.7	33.5	32.4	
	DRY DENSITY LB/CU FT	γd_c	89.1	89.5	90.8	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	.9	.9	.87	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	2.	4.	6.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.719	.768	.776	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	20	24	29	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.719	.768	.776	
INITIAL DIAMETER, IN.		D_o	1.41	1.4	1.41	
INITIAL HEIGHT, IN.		H_o	2.98	3.00	2.99	

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Lean clay, CL

LL 38	PL 16	PI 22	GS 2.71	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Dark gray, medium consistency, low to medium strength at PL, gloss shine, no shake response.

PROJECT CHASKA NCS-IA-84-4-ED-GH

BORING NO 83-58 SAMPLE NO. 3

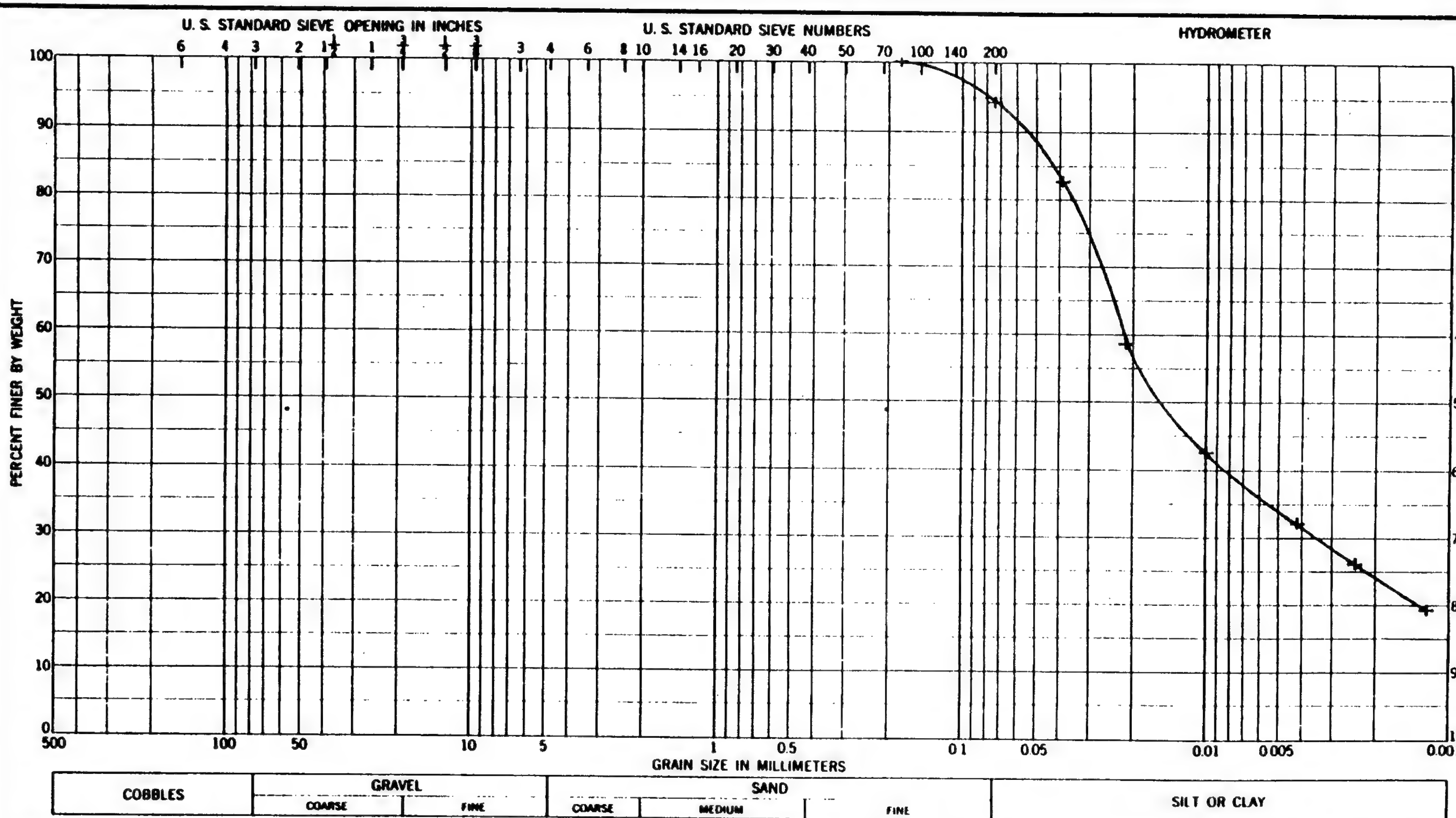
DEPTH ELEV 45.0-47.0

LABORATORY 84/84 DATE 07 DEC 1983

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) Figure 26

Figure C-116



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	45.0-47.0	Lean clay		38	16	22

Project: CHASKA NCS-IA-84-4-ED-GH

Area: MRD LAB NO. 84/34

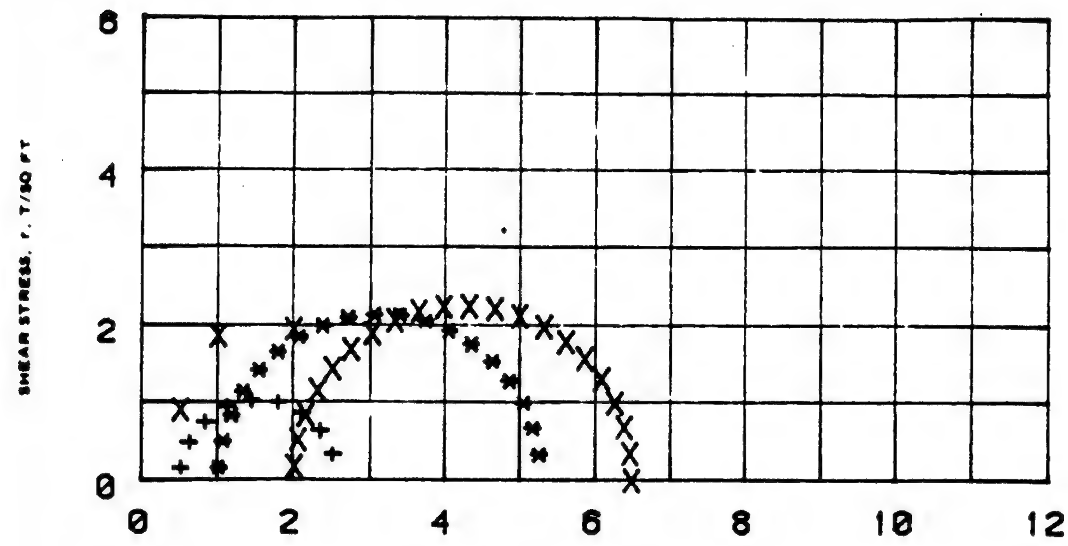
Boring No.: 83-58

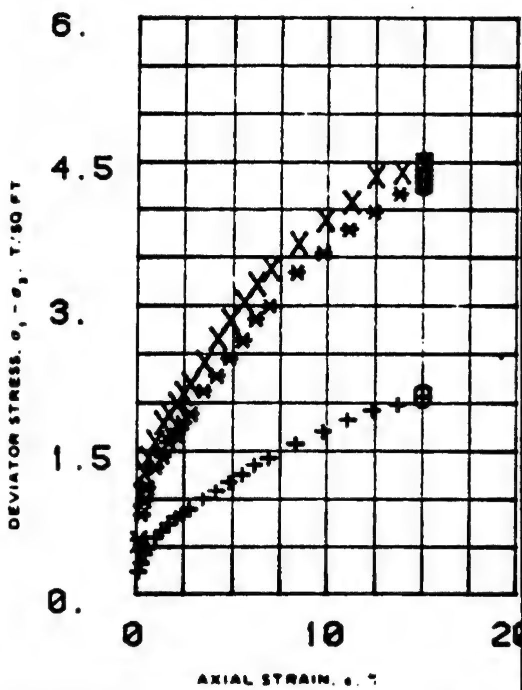
Date: 27 DEC 1983

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 27





NORMAL STRESS, σ, T/SQ FT

SPECIMEN NO			1	2	3	
INITIAL	WATER CONTENT, %	w_o	17.2	16.2	17.5	
INITIAL	DRY DENSITY LB/CU FT	γ_{d_o}	111.2	116.0	111.0	
INITIAL	SATURATION, %	S_o	95.	94.	95.	
INITIAL	VOID RATIO	e_o	.49	.46	.49	
BEFORE SHEAR	WATER CONTENT, %	w_c	16.2	16.6	17.	
BEFORE SHEAR	DRY DENSITY LB/CU FT	γ_{d_c}	112.1	115.8	118.2	
BEFORE SHEAR	SATURATION, %	S_c	100.	100.	100.	
BEFORE SHEAR	VOID RATIO	e_c	.48	.46	.46	
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	4.82	4.82	4.82	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	2.87	4.28	4.48	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1580	1801	1291	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	2.87	4.28	4.48	
INITIAL DIAMETER, IN		D_o	1.4	1.41	1.41	
INITIAL HEIGHT, IN		H_o	3.	2.99	2.99	

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CL

LL 33	PL 15	PI 18	G_s 2.68	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST $\bar{R}$

REMARKS Mottled browns, some dark brown and gray, stiff consistency, medium strength at PL, gloss shine, slow shake response. All 3 specimens required some patching.

PROJECT CHASKA NCS-IA-84-4-ED-GH

BORING NO 85-59 SAMPLE NO. 1

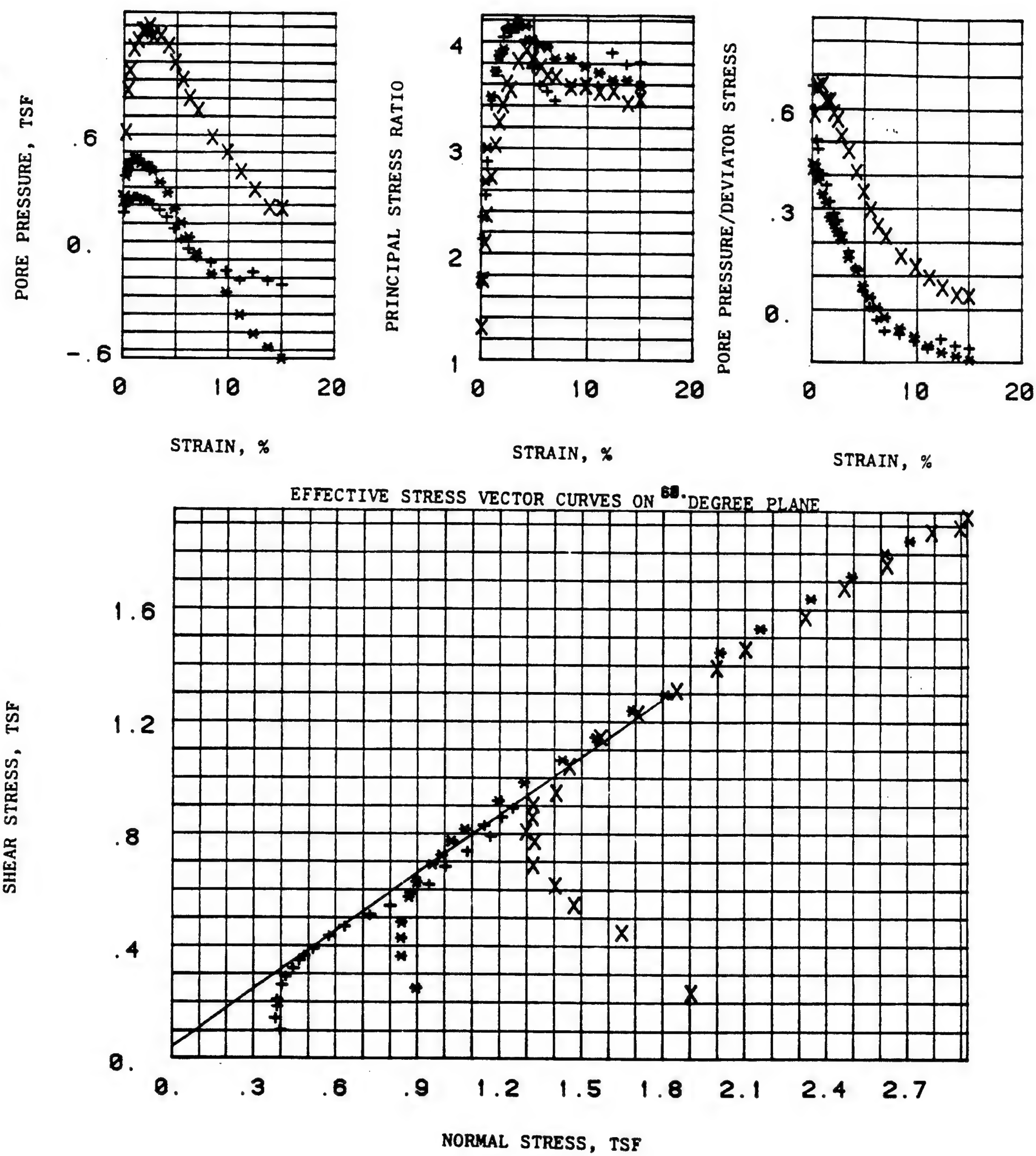
DEPTH ELEV 8.8-9.7

LABORATORY 84/84 DATE 10 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)*

Figure 7



REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

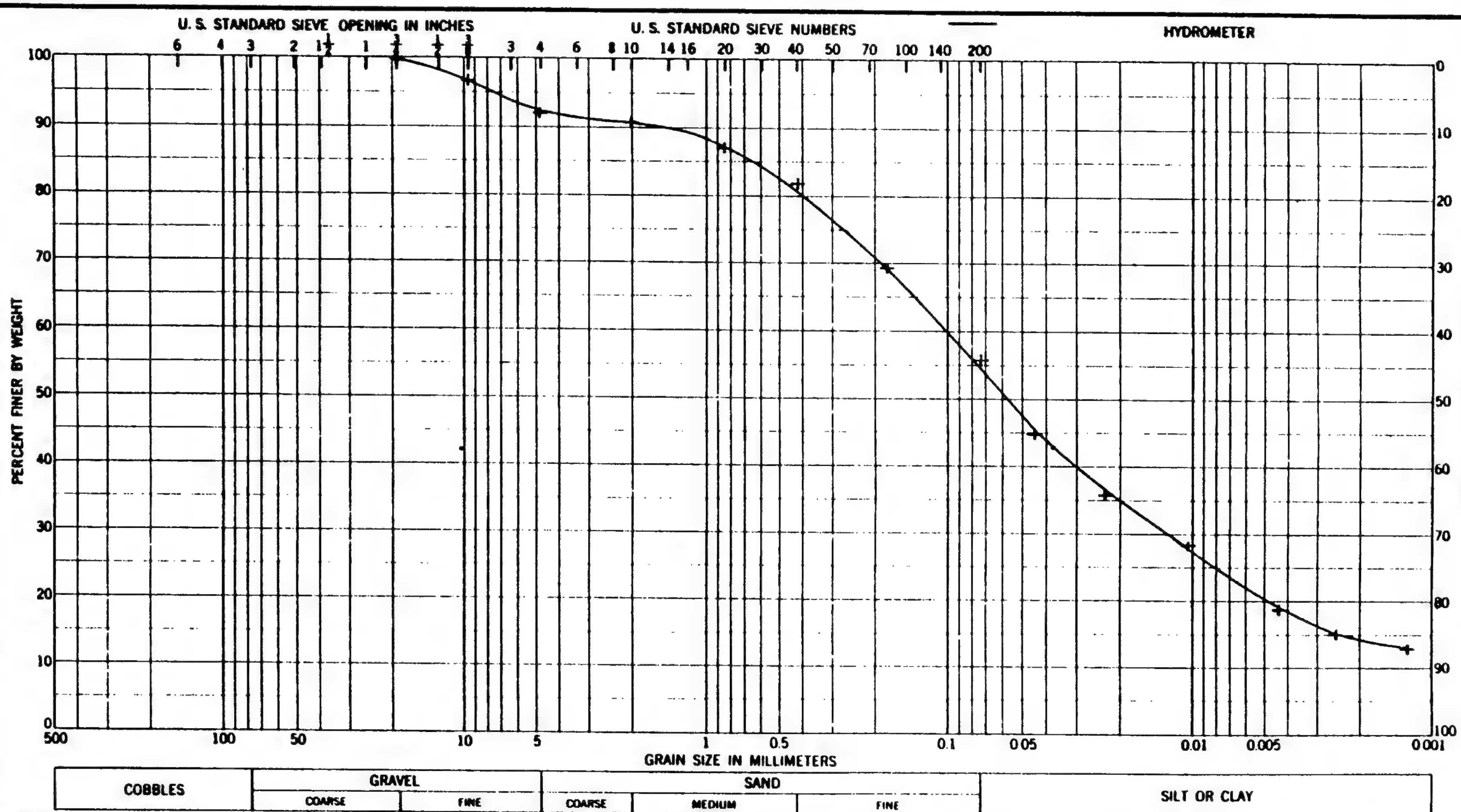
MRD Form 756, 1 May 80

PROJECT: CHASKA NCS-IA-84-4-ED-GH
BORING NO: 83-59 SAMPLE NO: 1
DEPTH/ELEV: 8.8-9.7
MRD LAB NO: 84/54 DATE: 10 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 8

Figure C-119



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
S-1	8.8-9.7	Sandy clay, CL		33	15	18

Project: CHASKA NCS-IA-84-4-ED-GH

Area: MRD LAB NO. 84/34

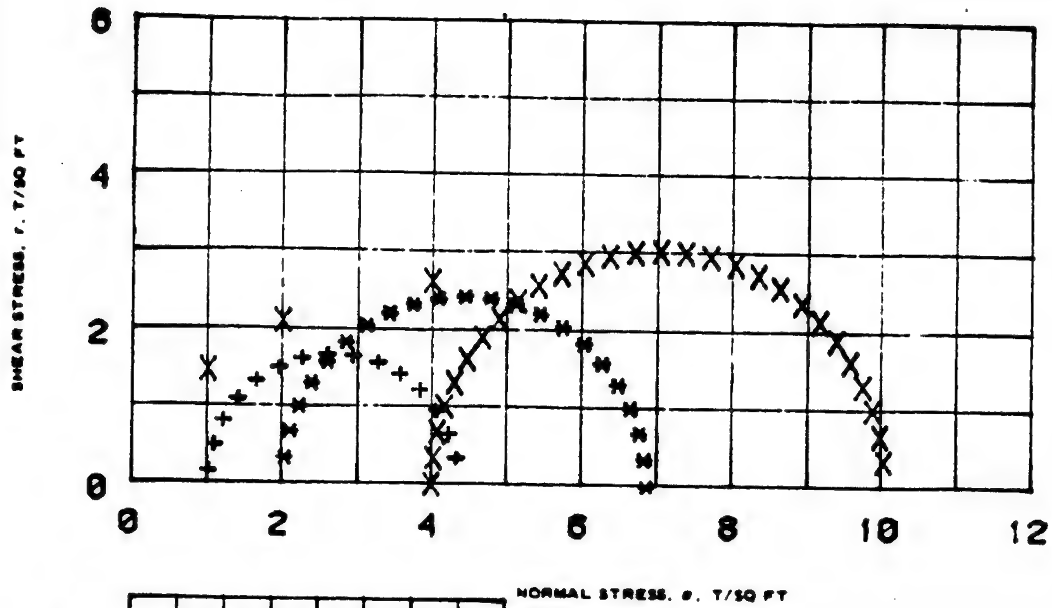
Boring No.: 83-59 MU

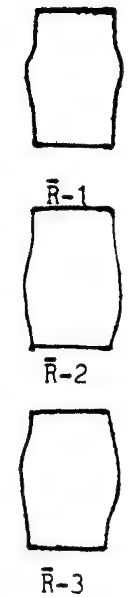
Date: 10 JAN 1984

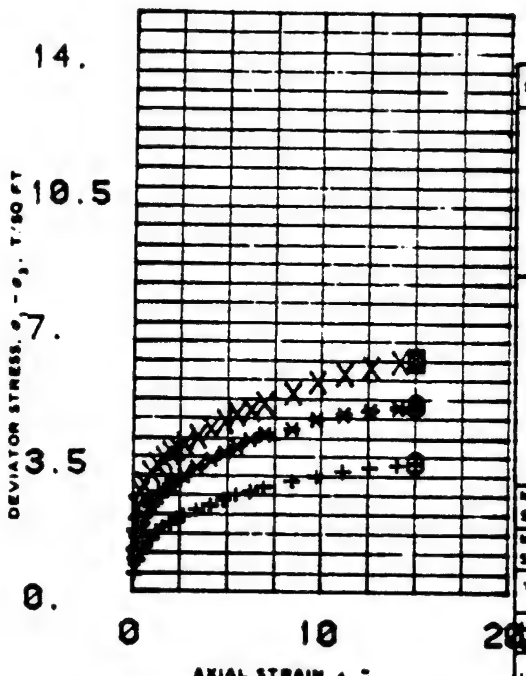
GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 9







SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	14.3	14.1	14.3	
	DRY DENSITY LB/CU FT	γ_{d_o}	119.4	119.1	118.1	
	SATURATION, %	S_o	96.	94.	95.	
	VOID RATIO	e_o	.4	.4	.41	
BEFORE SHEAR	WATER CONTENT, %	w_c	14.8	14.3	15.8	
	DRY DENSITY LB/CU FT	γ_{d_c}	121.4	122.1	123.5	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	.37	.37	.35	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.1	4.1	4.1	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	3.38	4.95	6.05	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1272	1278	1285	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	3.38	4.95	6.05	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.4	
INITIAL HEIGHT, IN.		H_o	2.99	3.	3.	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Clayey sand, SC

LL 30	PL 12	PI 18	G_s 2.67	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST R̄

REMARKS: Dark brown, very stiff consistency, medium strength at PL, low gloss shine. Tests required considerable patching. Sample contained one 3 inch rock.

PROJECT CHASKA NCS-IA-84-4-ED-GH

BORING NO 85-8EMU | SAMPLE NO. 8-2

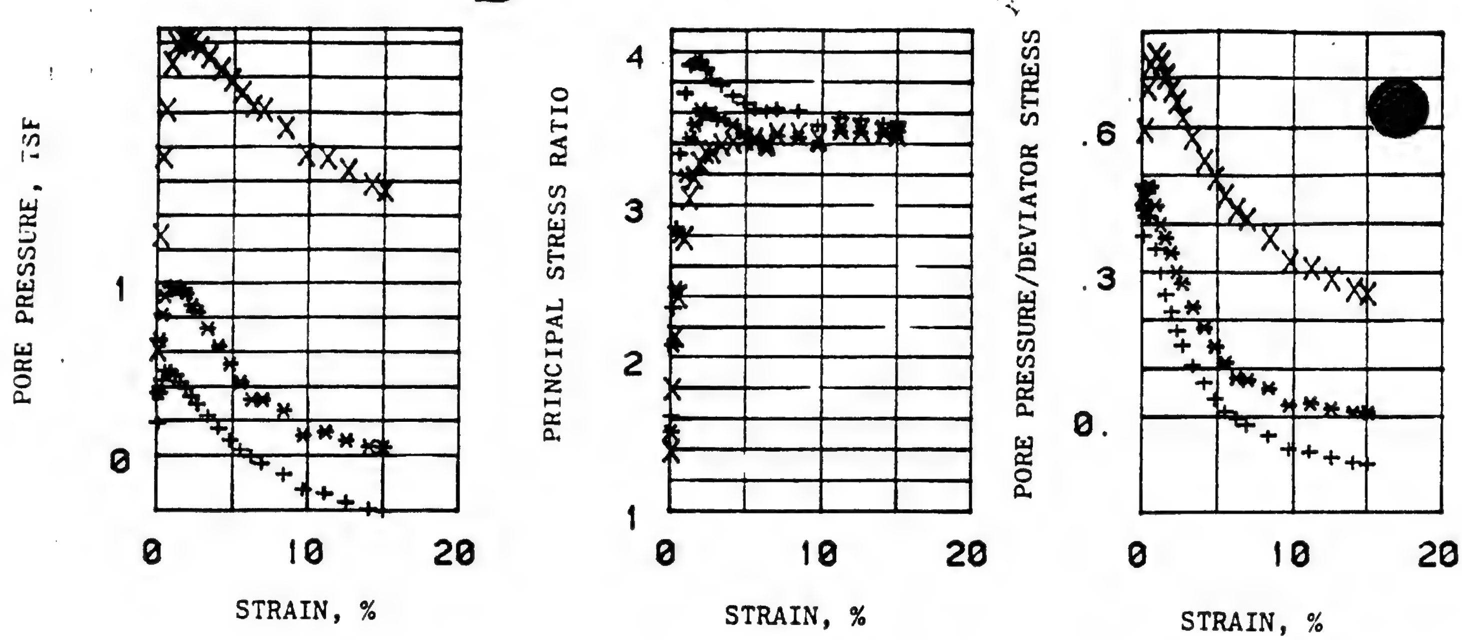
DEPTH ELEV 11.8-12.5

LABORATORY 84/84 | DATE 8 FEB 1984

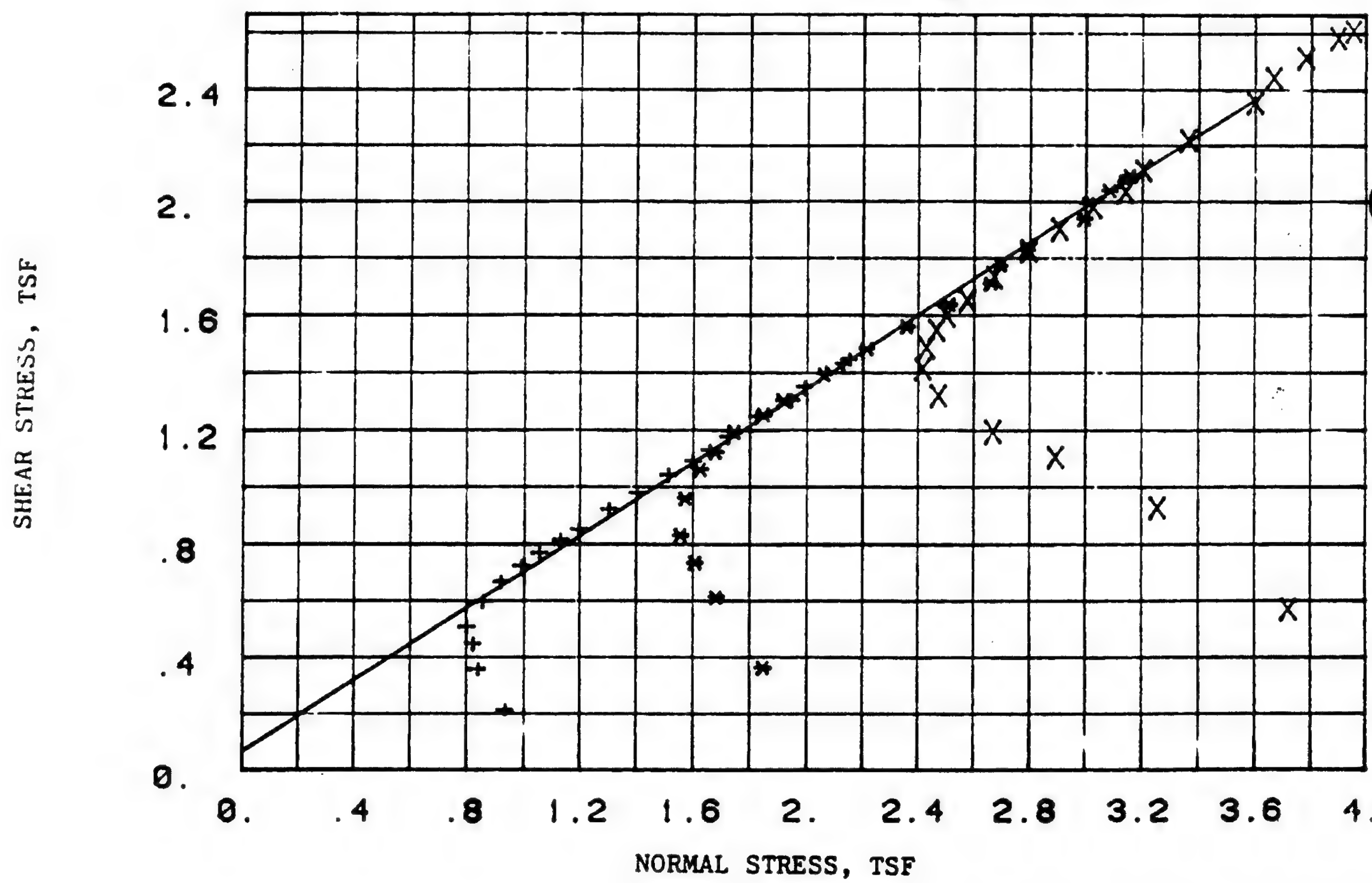
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089
REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 1



EFFECTIVE STRESS VECTOR CURVES ON 60. DEGREE PLANE



REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

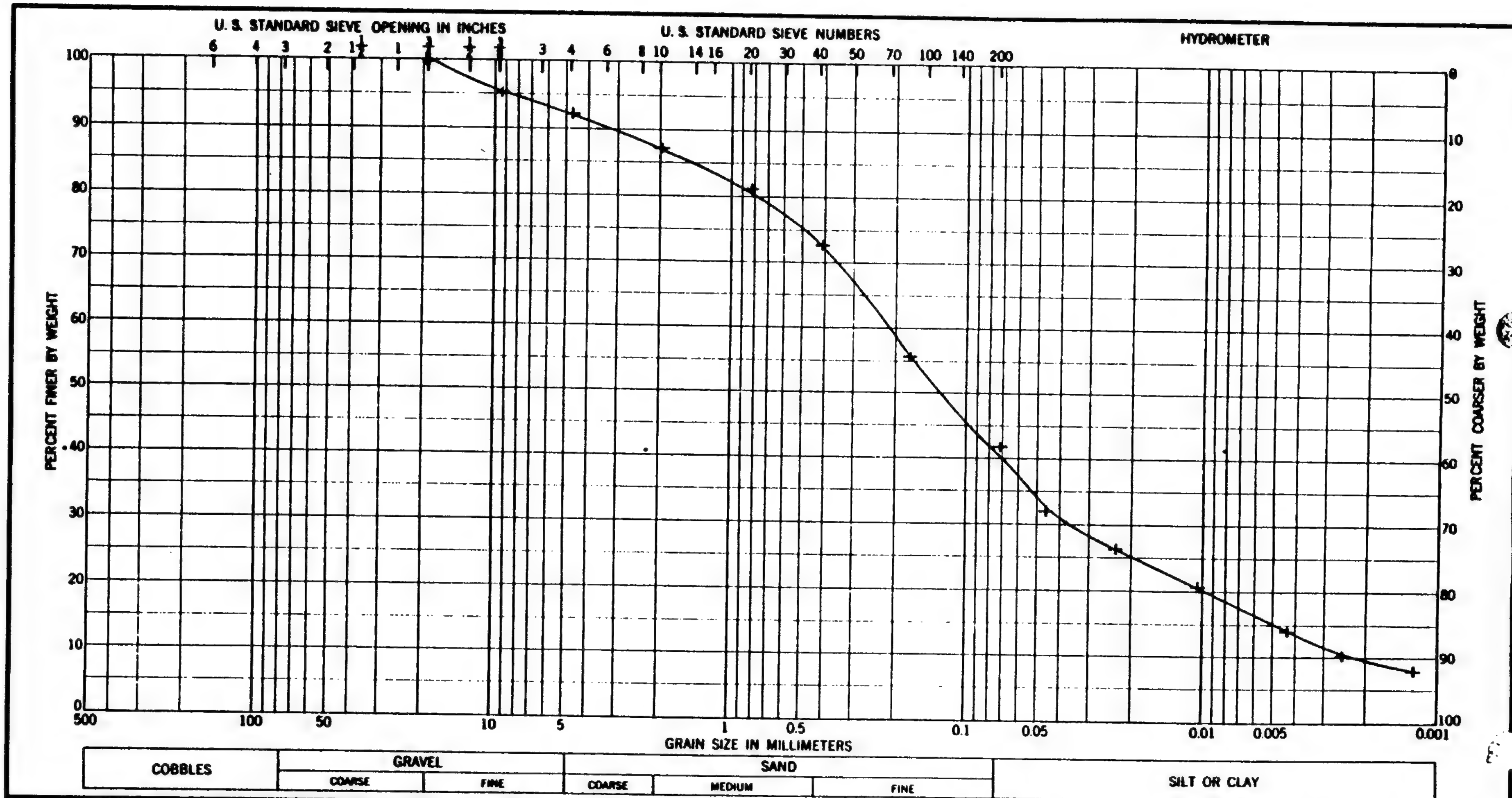
PROJECT:	CHASKA NCS-IA-84-4-ED-GH		
BORING NO:	83-6GMU	SAMPLE NO:	S-
DEPTH/ELEV:	11.5-12.5		
MRD LAB NO:	84/54	DATE:	3 FEB 1984

TRIAXIAL COMPRESSION TEST REPORT

MRD Form 756, 1 May 80

FIGURE: 2

Figure C-122



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
S-2	11.0-12.5	Clayey sand, SC		30	12	18

Project: CHASKA NCS-IA-84-4-ED-GH

Area: MRD LAB NO. 84/54

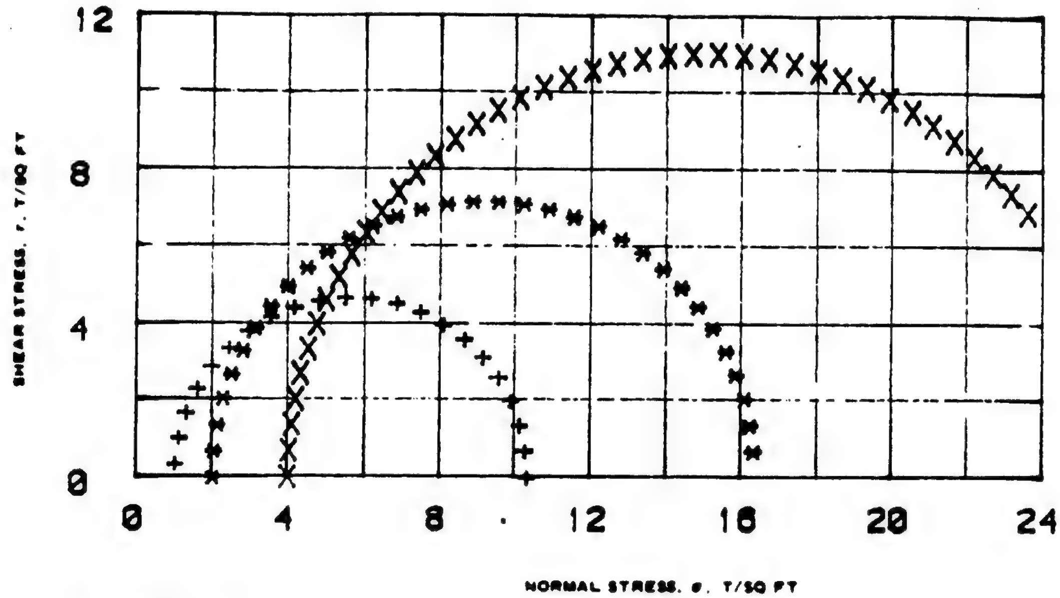
Boring No. 83-60 MU

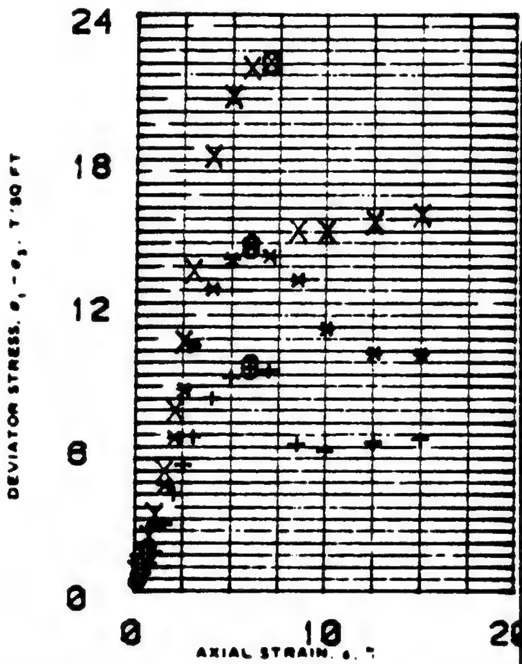
Date: 8 FEB 1984

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 3





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	20.2	19.7	19.9
	DRY DENSITY LB/CU FT	γd_o	109.1	110.5	109.9
	SATURATION, %	S_o	100.	100.	100.
	VOID RATIO	e_o	.55	.53	.53
BEFORE SHEAR	WATER CONTENT, %	w_c	20.1	19.8	19.9
	DRY DENSITY LB/CU FT	γd_c	109.1	110.5	109.9
	SATURATION, %	S_c	99.	100.	100.
	VOID RATIO	e_c	.55	.53	.53
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	9.55	14.4	22.
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	14	15	19
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	5.82	9.09	15.
INITIAL DIAMETER, IN		D_o	1.4	1.39	1.39
INITIAL HEIGHT, IN		H_o	3.00	2.99	2.99

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Clayey silt, CL-ML

LL 23 | PL 19 | PI 4 | G_s 2.7 | TYPE OF SPECIMEN UNDIST. | TYPE OF TEST Q

REMARKS Gray, stiff consistency, low strength at PL, no shine, fast shake response, highly calcareous.

PROJECT CHABKA NC-IA-84-ED-0H

BORING NO 83-61 | SAMPLE NO. 1

DEPTH ELEV 16.0-17.0

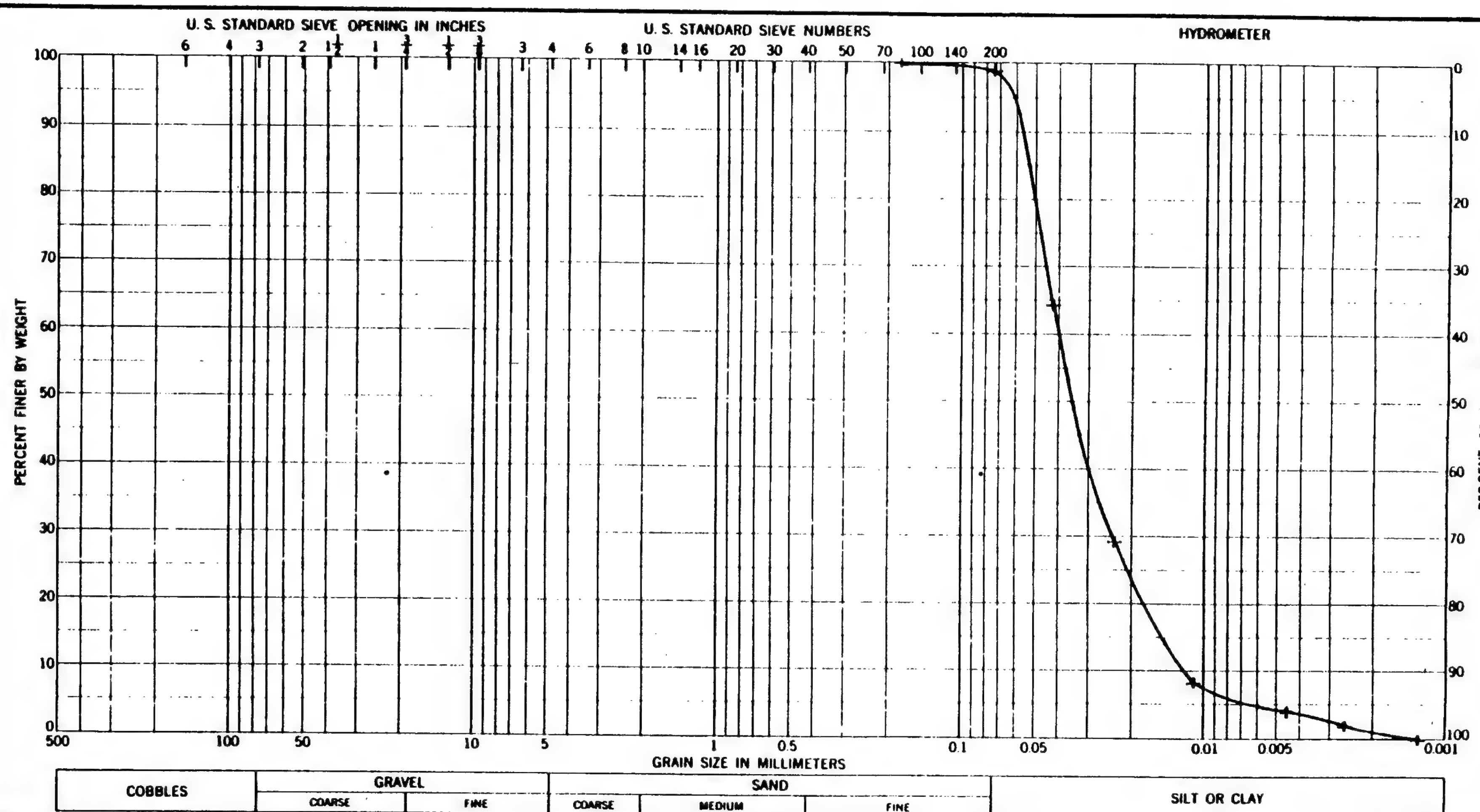
LABORATORY 04/84 | DATE 11 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

Figure 12

Figure C-124



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	16.0-17.6	Clayey silt, CL-ML		23	19	4

Project CHASKA NCS-IA-84-4-ED-GH

Area MRD LAB NO. 84/34

Boring No. 83-61

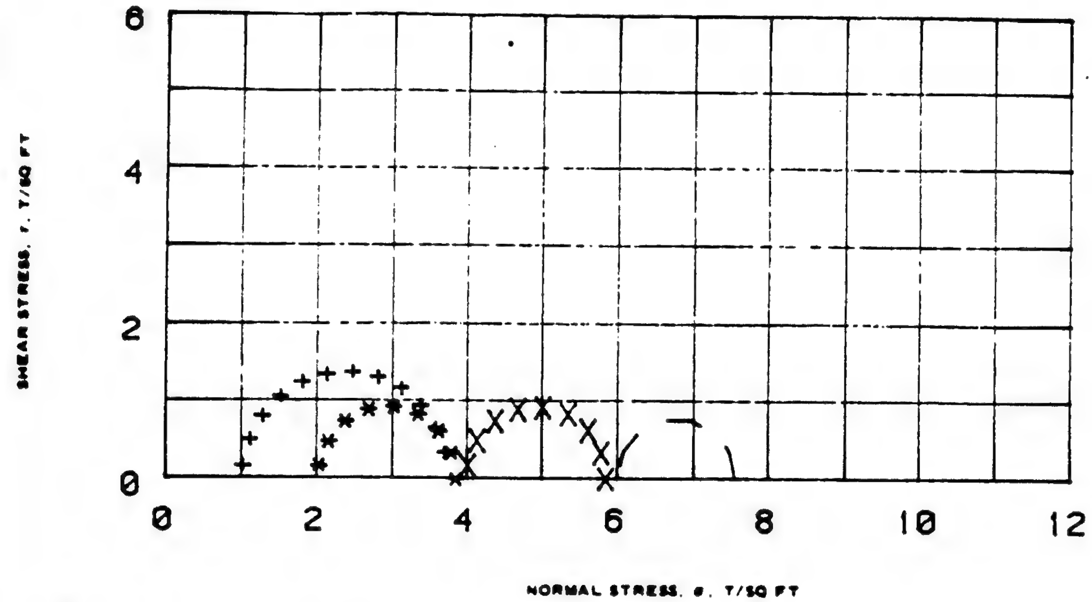
Date 11 JAN 1984

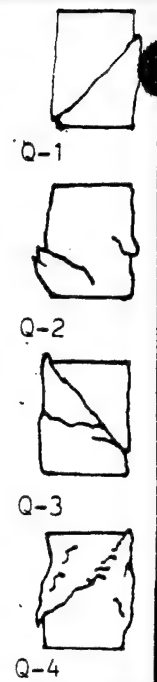
GRADATION CURVES

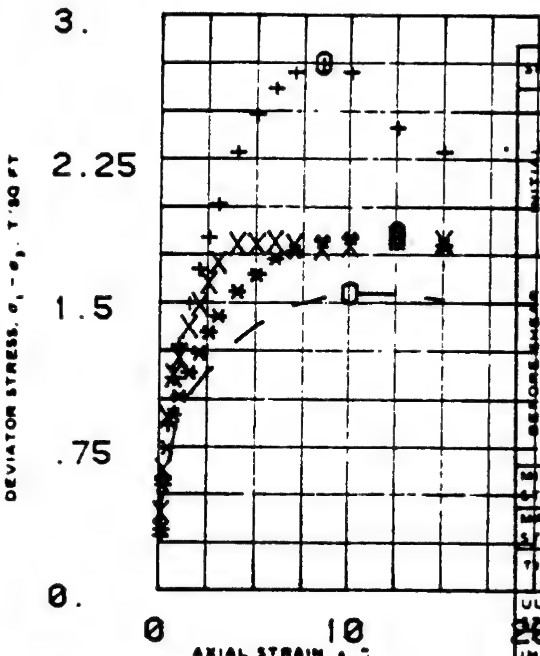
ENG FORM 1 MAY 63 2087

FIGURE 13

Figure C-125







SPECIMEN NO			1	2	3	4
INITIAL	WATER CONTENT, %	w_0	27.3	29.2	27.3	30.5
	DRY DENSITY LB/CU FT	γ_{d_0}	97.2	94.7	97.3	92.9
	SATURATION, %	S_0	100.	100.	100.	100.
	VOID RATIO	e_0	.74	.79	.74	.82
BEFORE SHEAR	WATER CONTENT, %	w_c	27.3	29.1	27.3	30.4
	DRY DENSITY LB/CU FT	γ_{d_c}	97.2	94.7	97.4	93.5
	SATURATION, %	S_c	100.	100.	100.	100.
	VOID RATIO	e_c	.74	.79	.74	.81
	FINAL BACK PRESSURE, T/SQ FT	u_0	0.	0.	0.	0.
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	6.
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	2.75	1.86	1.84	1.55
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	17	24	24	19
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	2.29	1.81	1.82	1.51
INITIAL DIAMETER, IN.		D_0	1.39	1.39	1.4	1.39
INITIAL HEIGHT, IN.		H_0	2.99	2.99	2.99	2.99

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Lean varved clay, CL

LL 46	PL 16	PI 30	Gs 2.71	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Mottled gray, stiff consistency, medium strength at PL, gloss shine, no shake response, highly calcareous. Plate 1&2 shows 1/8" bedding in varved clay.

PROJECT CHASKA NCS-IA-84-4-ED-GH

BORING NO 83-61 SAMPLE NO. 2

DEPTH ELEV 32.0-34.0

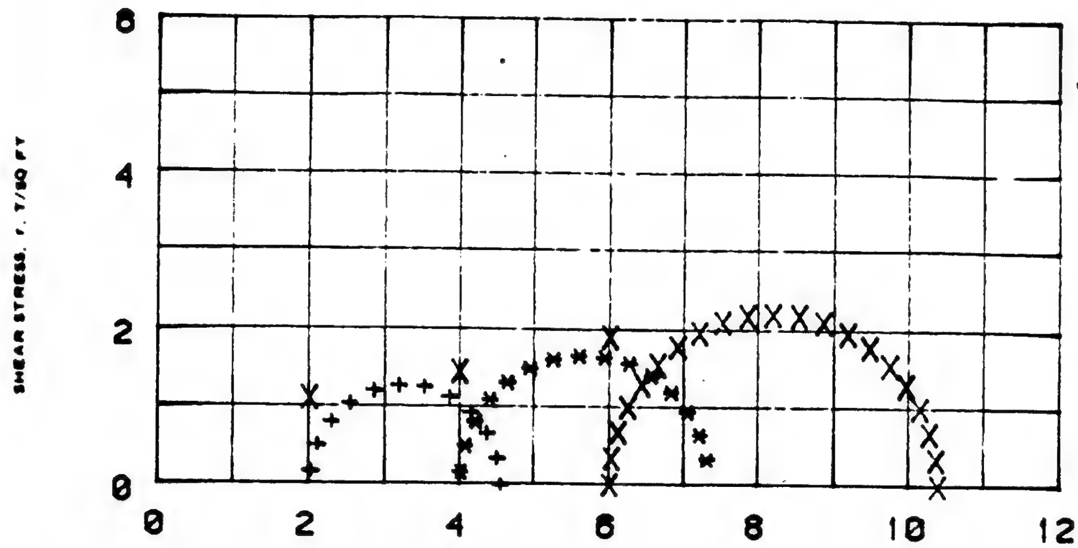
LABORATORY 84/34 DATE 27 DEC 1983

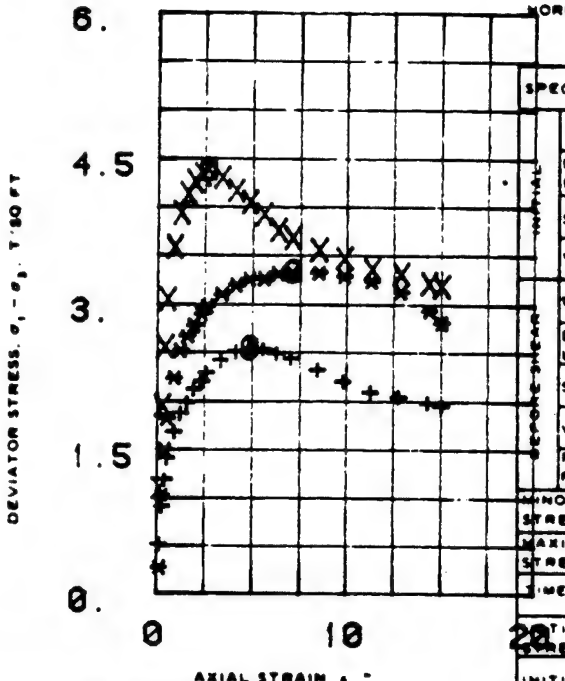
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 28

Figure C-126





SPECIMEN NO			1	2	3
INITIAL	WATER CONTENT %	w_o	28.5	29.7	28.2
	DRY DENSITY LB/CU FT	γ_{d_o}	96.7	94.2	98.4
	SATURATION, %	S_o	100.	100.	100.
	VOID RATIO	e_o	.77	.80	.78
BEFORE SHEAR	WATER CONTENT, %	w_c	28.7	28.8	27.8
	DRY DENSITY LB/CU FT	γ_{d_c}	98.2	98.8	101.1
	SATURATION %	S_c	100.	100.	100.
	VOID RATIO	e_c	.72	.72	.67
	FINAL BACK PRESSURE, T/SQ FT	u_o	2.00	2.06	2.00
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	2.	4.	6.
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	2.58	3.54	4.59
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	420	[illegible]	240
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.97	2.88	3.19
INITIAL DIAMETER, IN		D_o	1.39	1.39	1.39
INITIAL HEIGHT, IN		H_o	2.99	2.99	2.99

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL B value 0.99 1.00 1.00

LL 46	PL 16	PI 30	Gs 2.71	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST R̄

REMARKS

PROJECT CHASKA NCS-IA-84-4-ED-BH

BORING NO 85-01 SAMPLE NO 2

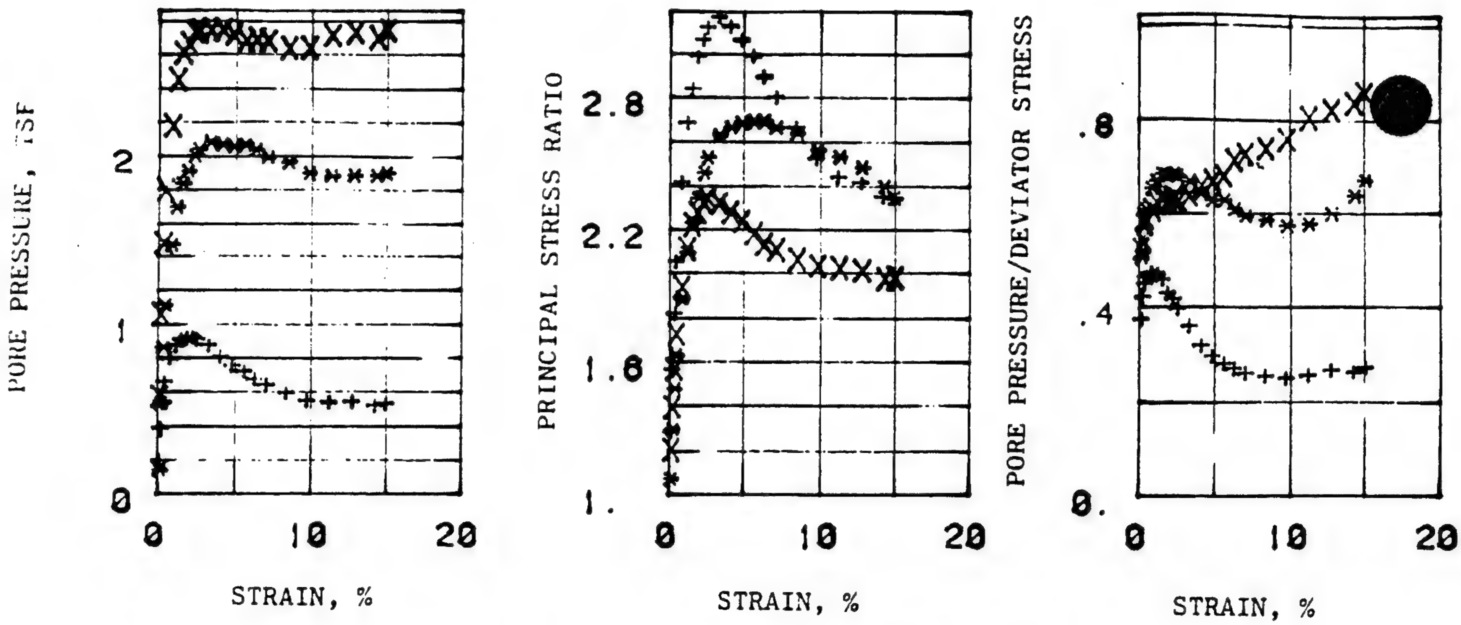
DEPTH ELEV

LABORATORY 84/84 DATE 8 FEB 1984

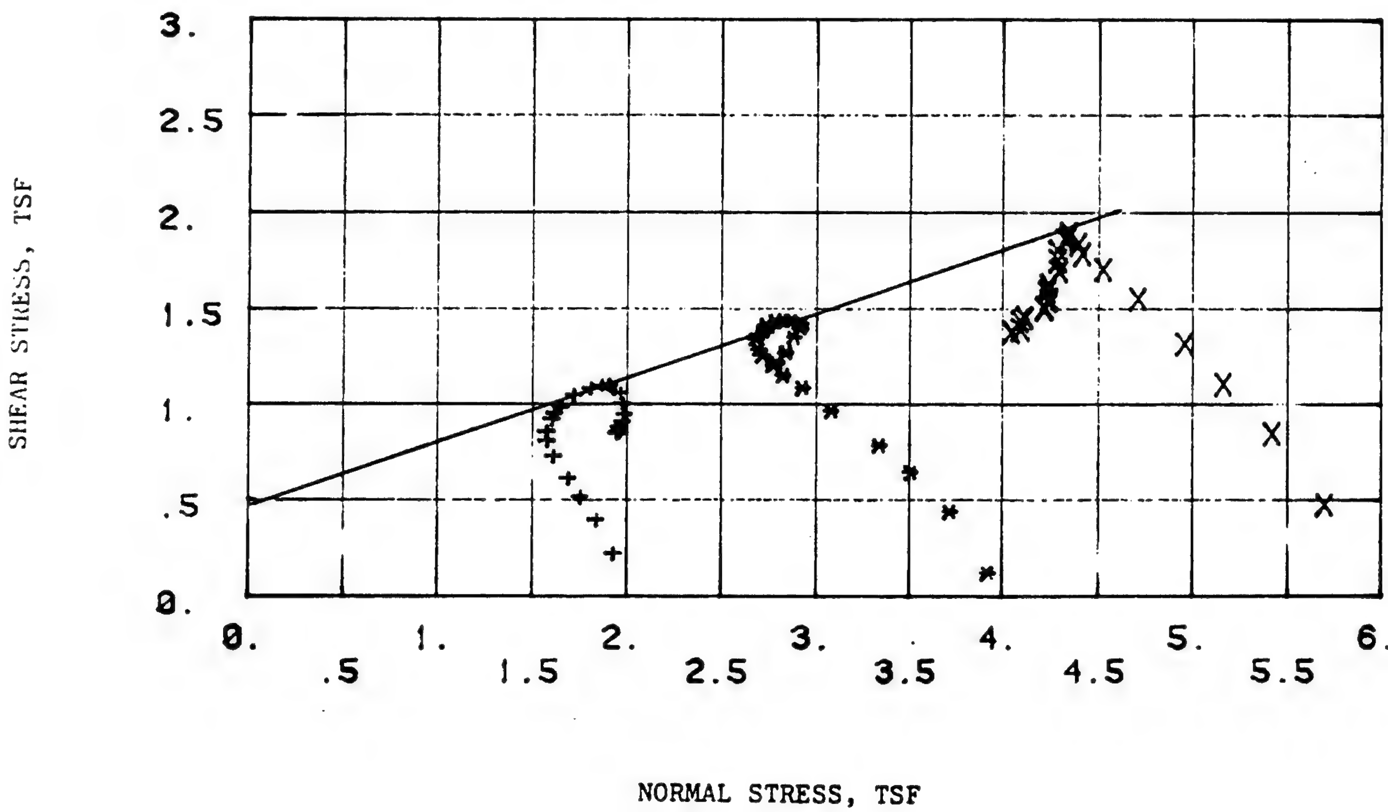
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 4



EFFECTIVE STRESS VECTOR CURVES ON 60. DEGREE PLANE



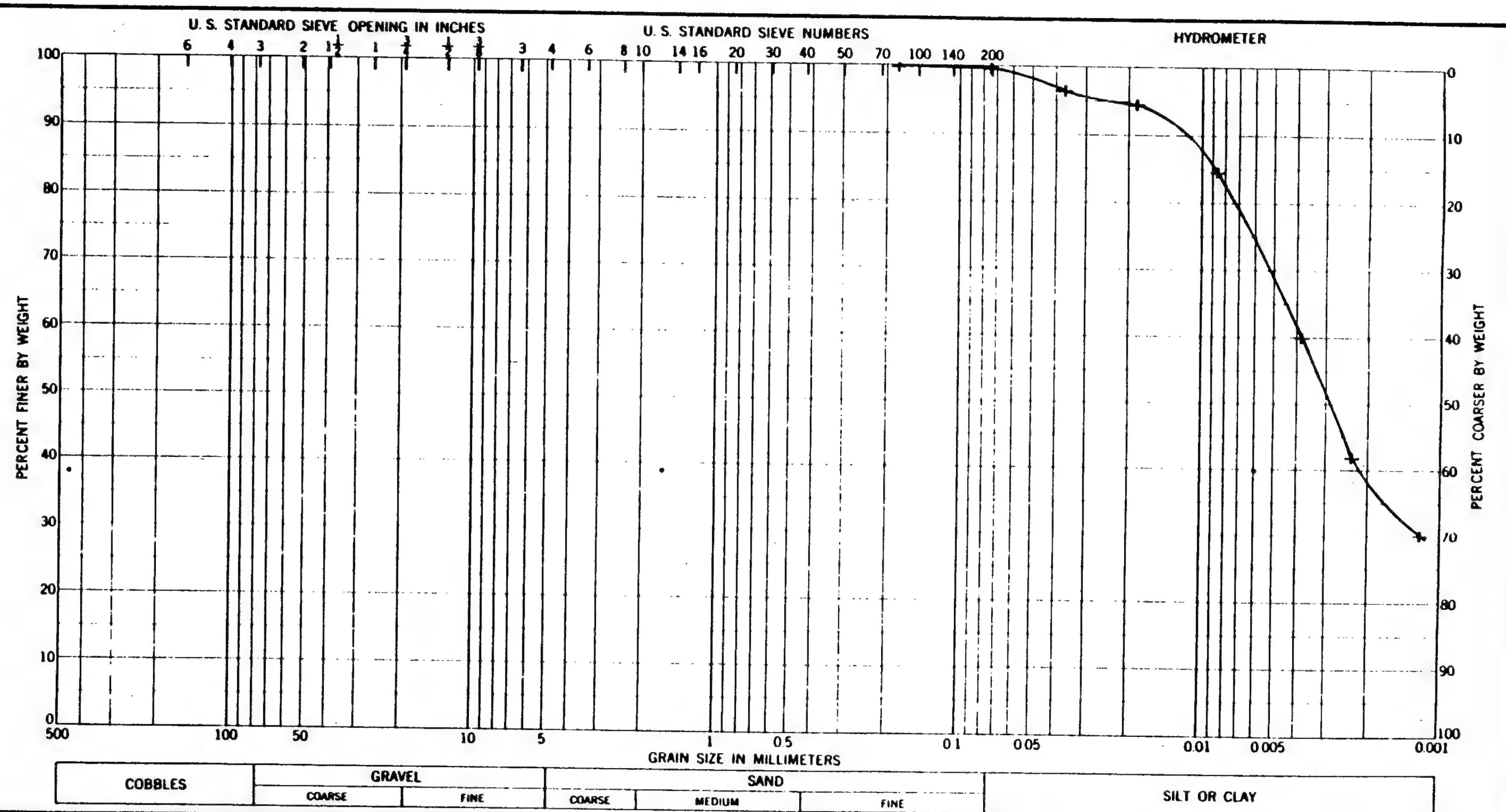
REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
$\bar{R}$ TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

PROJECT:	CHASKA NCS-IA-84-4-ED-SH		
BORING NO:	83-81	SAMPLE NO:	2
DEPTH/ELEV:			
MRD LAB NO:	84/34	DATE:	8 FEB 1984

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 5

MRD Form 756, 1 May 80



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	32.0-34.0	Lean varved clay, CL		46	16	30

Project CHASKA NCS-IA-84-4-ED-GH

Area MRD LAB NO. 84/34

Boring No. 83-61

Date 27 DEC 1983

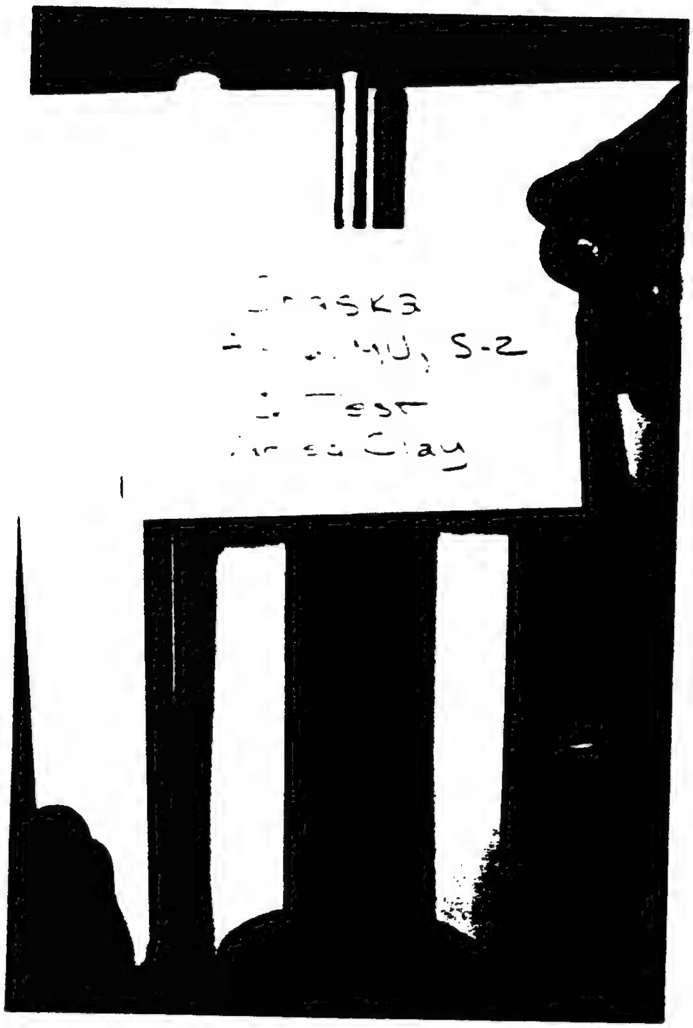
GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 29

Figure C-129

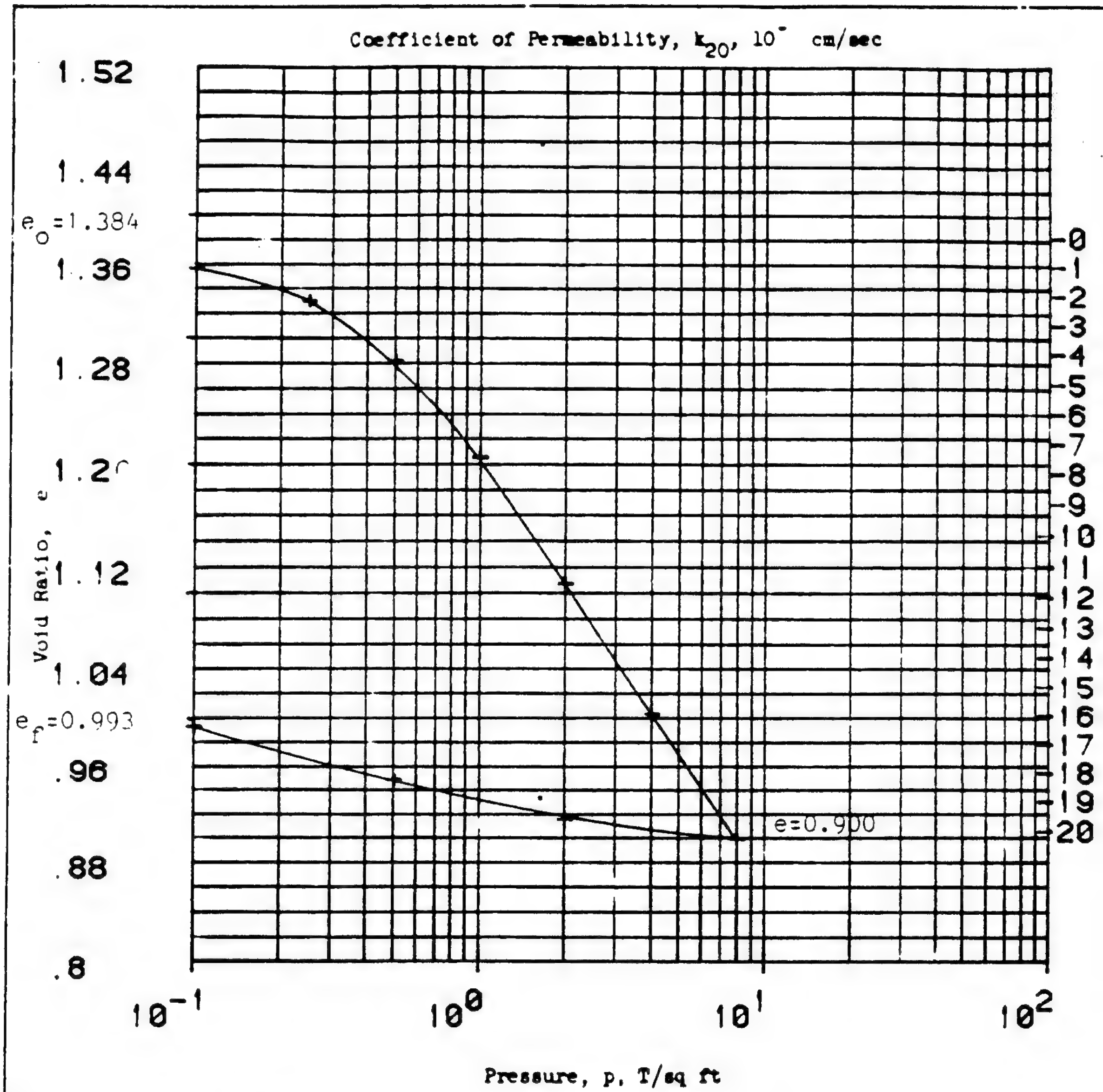
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska



Boring 83-61, Sample 2.
Bedding fold may indicate insitu slumping.

Plate 1

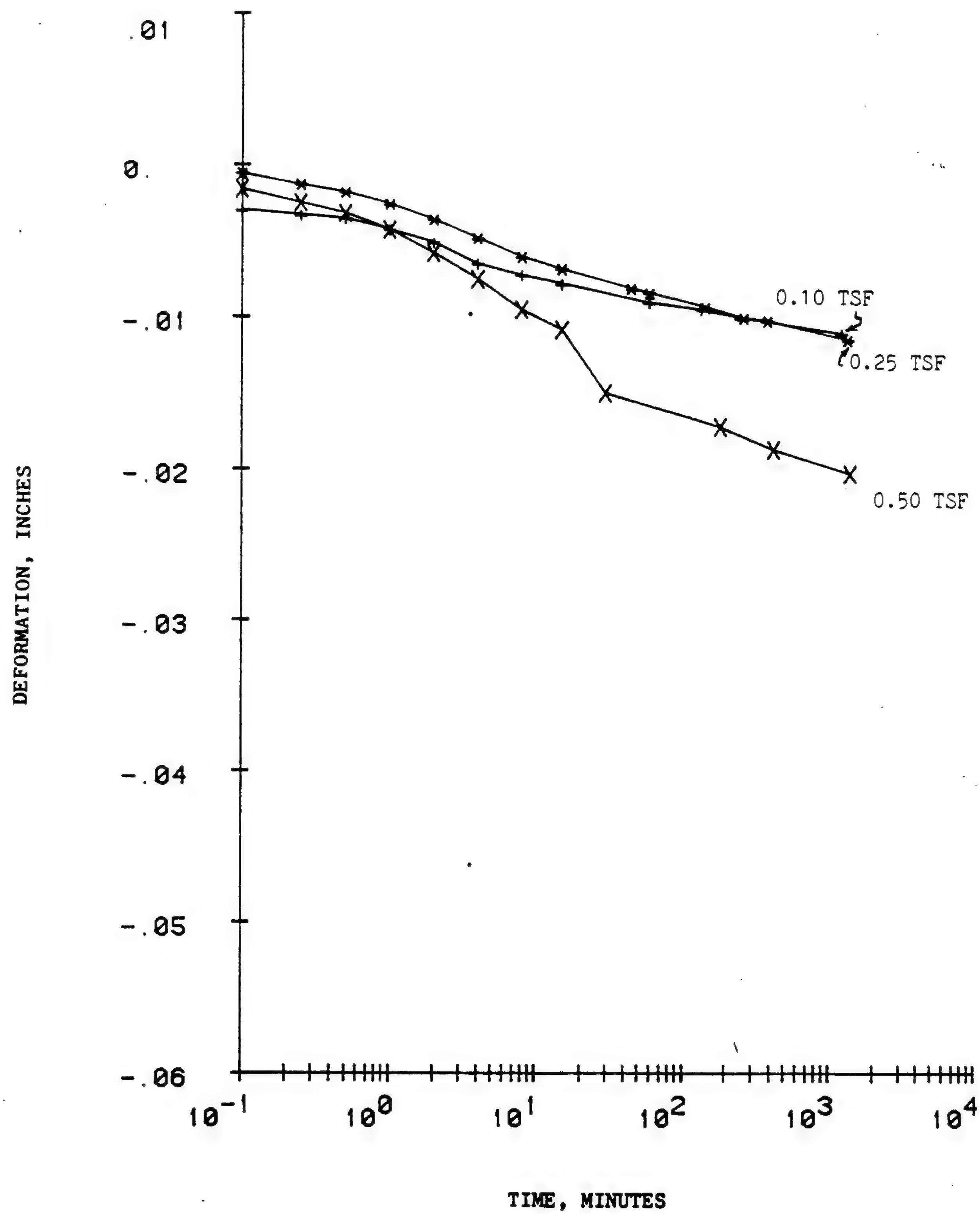
Boring, 83-61, Sample 2.
Bedding fold may indicate insitu slumping.



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.29 in.	Ht 1. in.	Water Content, w_o	40.6 %	w_f	37.8 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.38	e_f	.99
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	94. %	S_f	100. %
Compression Index, C_c		Dry Density, γ_d	69.9 lb/ft³		
Classification Fat clay, CH		k_{20} at e_o = x 10⁻ cm/sec			
LL 80	G_s 2.67	Project CHASKA NCS-IA-84-4-ED-GH			
PL 29	D_{10}				
Remarks		Area MRD LAB NO: 84/34			
		Boring No. 83-62 MU		Sample No. 1	
		Depth El 4.0-5.6		Date 10 JAN 1984	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 11



PROJECT: CHASKA NCS-IA-84-4-ED-GH

MRD LAB NO: 84/34

DATE: 10 JAN 1984

BORING NO: 83-62 MU

SAMPLE NO: 1

DEPTH/ELEV: 4.8-5.6

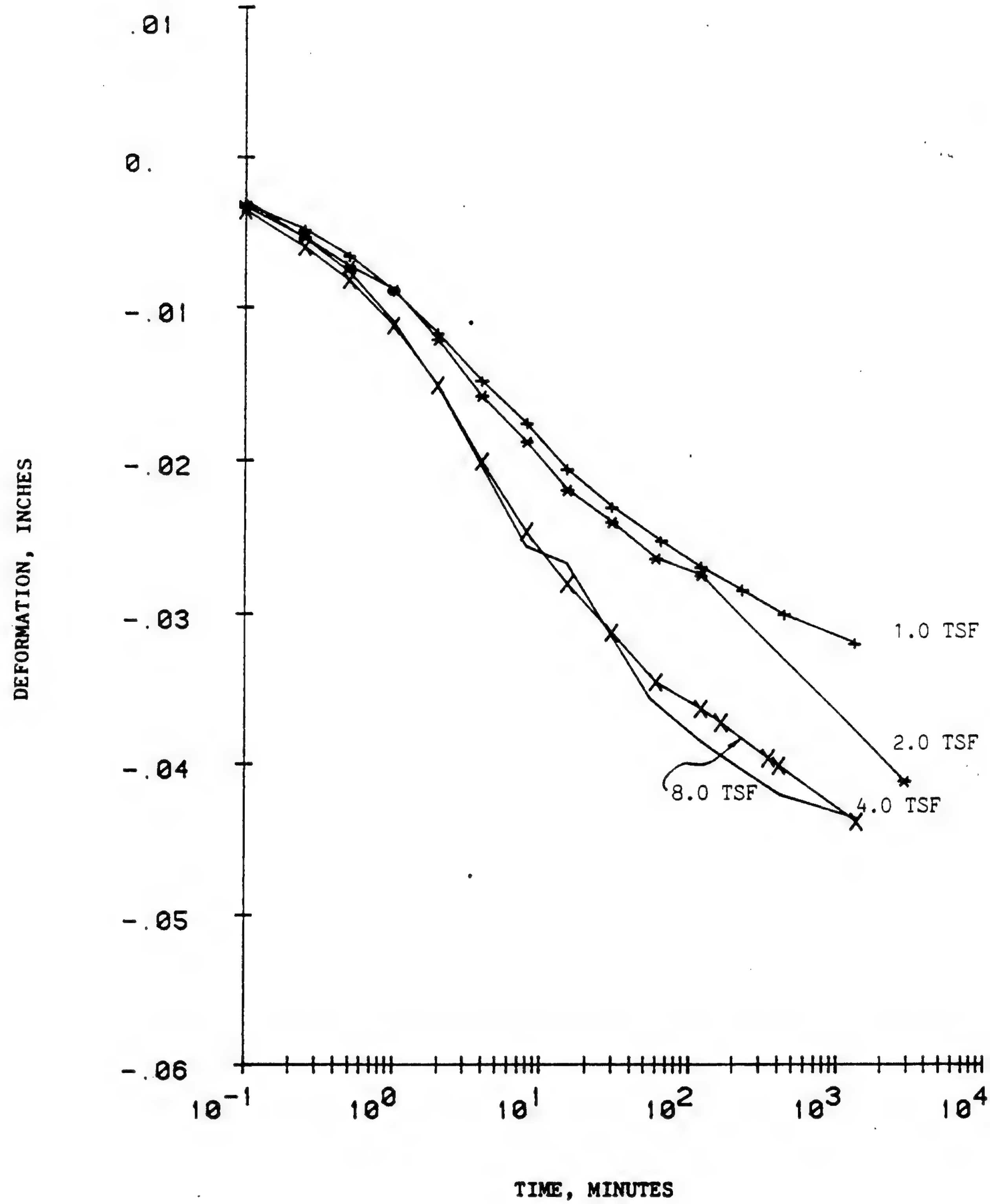
COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 12

Figure C-133

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-84-4-ED-GH

MRD LAB NO: 84/34 DATE: 10 JAN 1984

BORING NO: 83-62 MU SAMPLE NO: 1 DEPTH/ELEV: 4.8-5.6

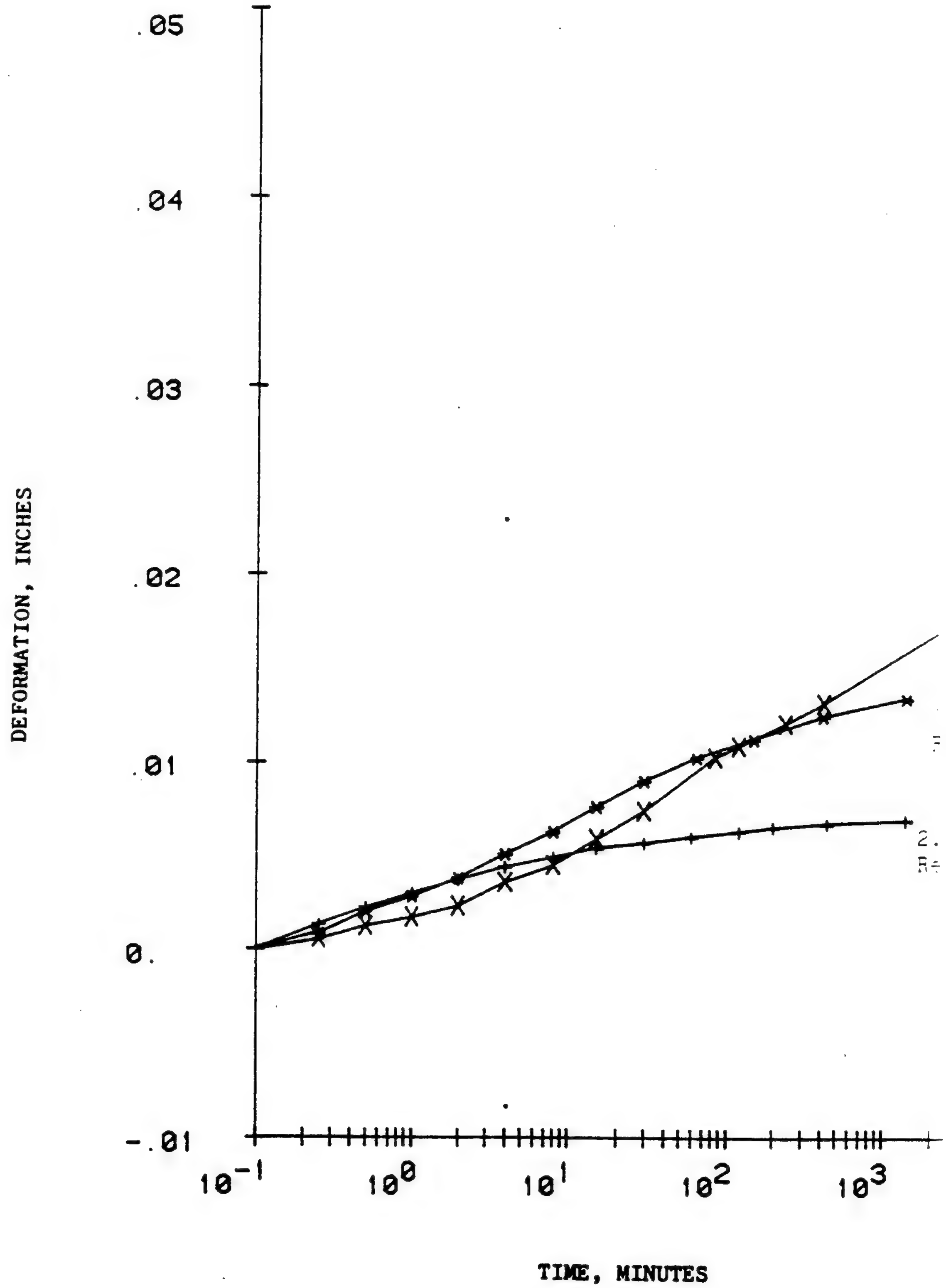
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 13

Figure C-134

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-84-4-ED-GH

MRD LAB NO: 84/34

DATE: 10 JAN 19

BORING NO: 83-62 MU

SAMPLE NO: 1

DEPTH/ELEV: 4.0-

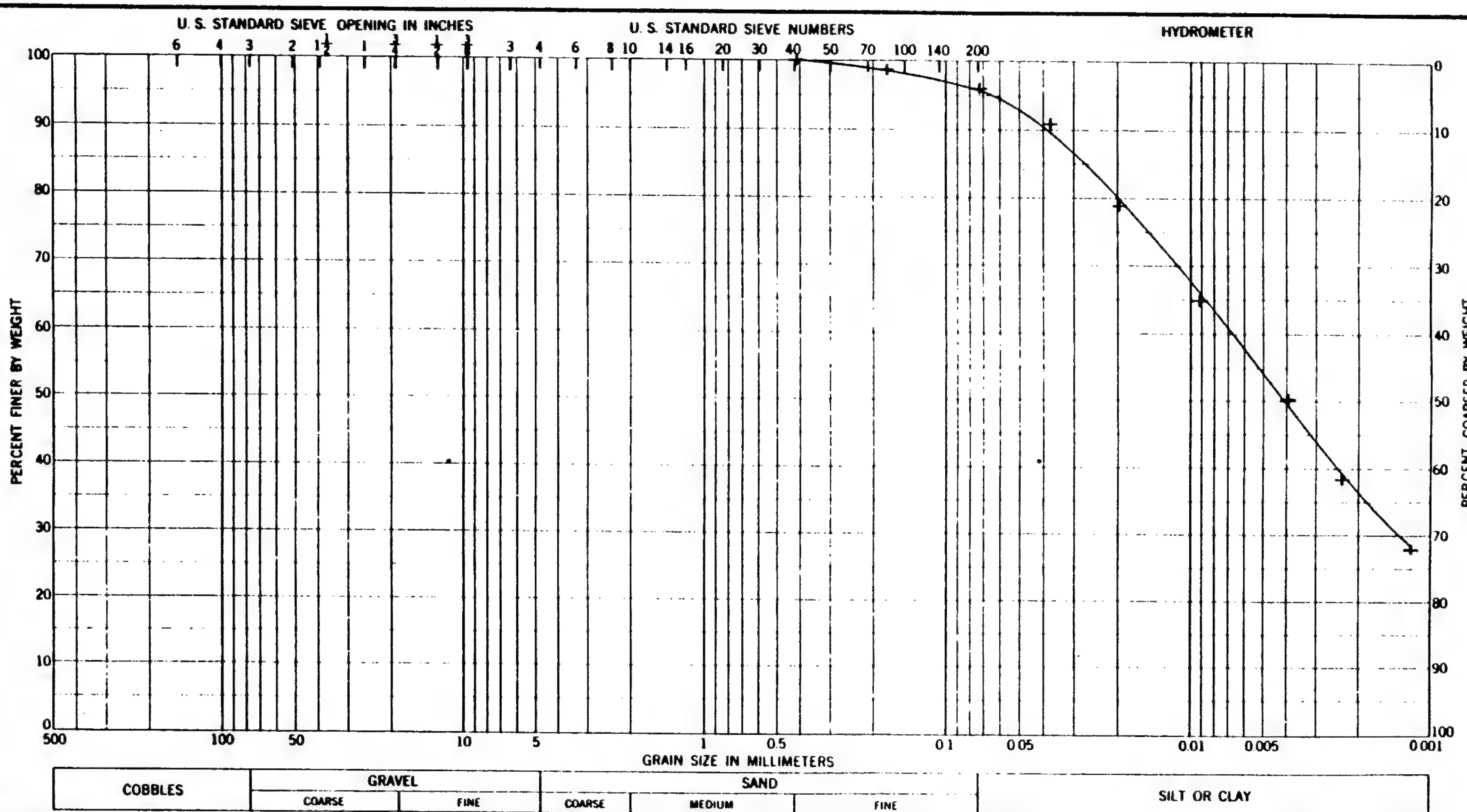
CONSOLIDATION TEST—TIME CUR

COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088

FIGURE: 14

Figure C-135

MRD Form 956, 1 May 80



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
VAX 1	4.8-5.6	Fat clay, CH		80	29	51

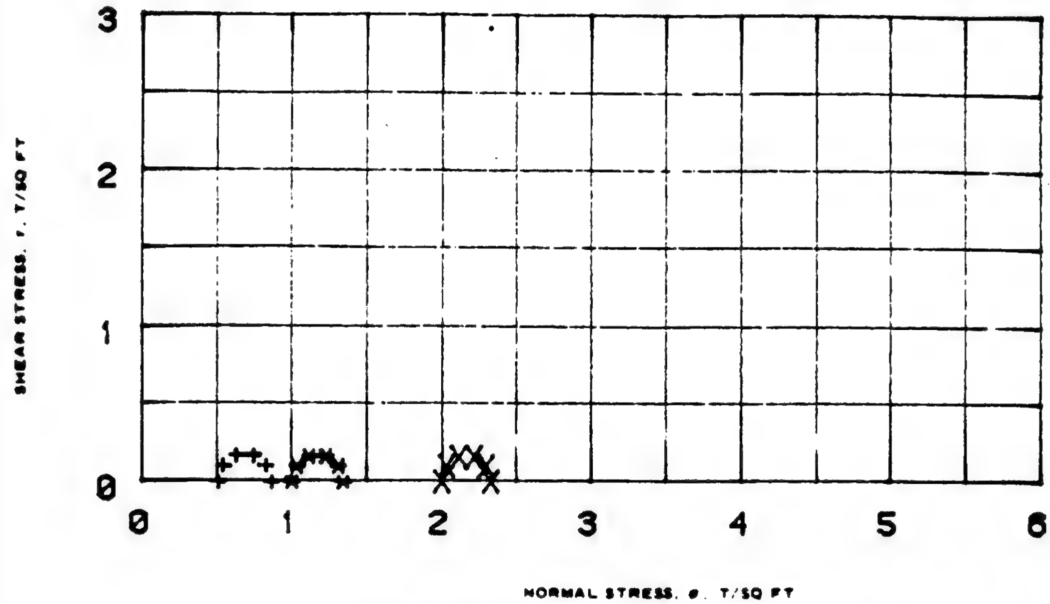
Project	CHASKA NCS-IA-84-4-ED-GH
Area	MRD LAB NO. 84/34
Boring No.	83-62
Date	10 JAN 1984

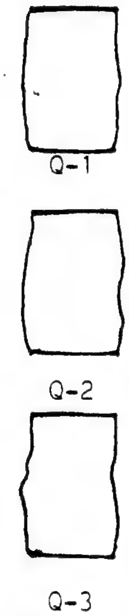
GRADATION CURVES

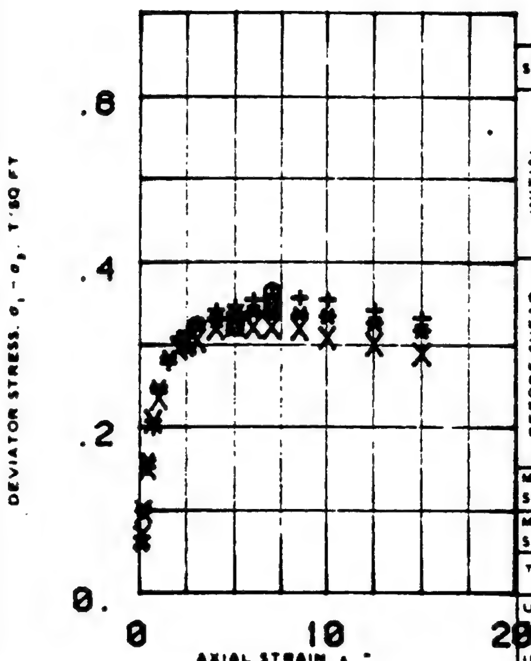
ENG FORM 1 MAY 63 2087

FIGURE 15

Figure C-136







SPECIMEN NO			1	2	3	
INITIAL	WATER CONTENT, %	w_o	52.5	53.3	54.3	
	DRY DENSITY LB/CU FT	γ_{d_o}	69.1	68.5	67.2	
	SATURATION, %	S_o	99.	99.	98.	
	VOID RATIO	e_o	1.41	1.44	1.48	
BEFORE SHEAR	WATER CONTENT, %	w_c	52.2	52.9	53.9	
	DRY DENSITY LB/CU FT	γ_{d_c}	69.1	68.5	67.2	
	SATURATION, %	S_c	99.	98.	97.	
	VOID RATIO	e_c	1.41	1.44	1.48	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.381	.345	.325	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	15	14	9	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.355	.318	.299	
INITIAL DIAMETER, IN		D_o	1.41	1.41	1.42	
INITIAL HEIGHT, IN		H_o	2.97	2.98	2.97	

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Fat clay, CH

LL 80	PL 29	PI 51	G_s 2.67	TYPE OF SPECIMEN UNDIST.	TYPE OF TEST Q

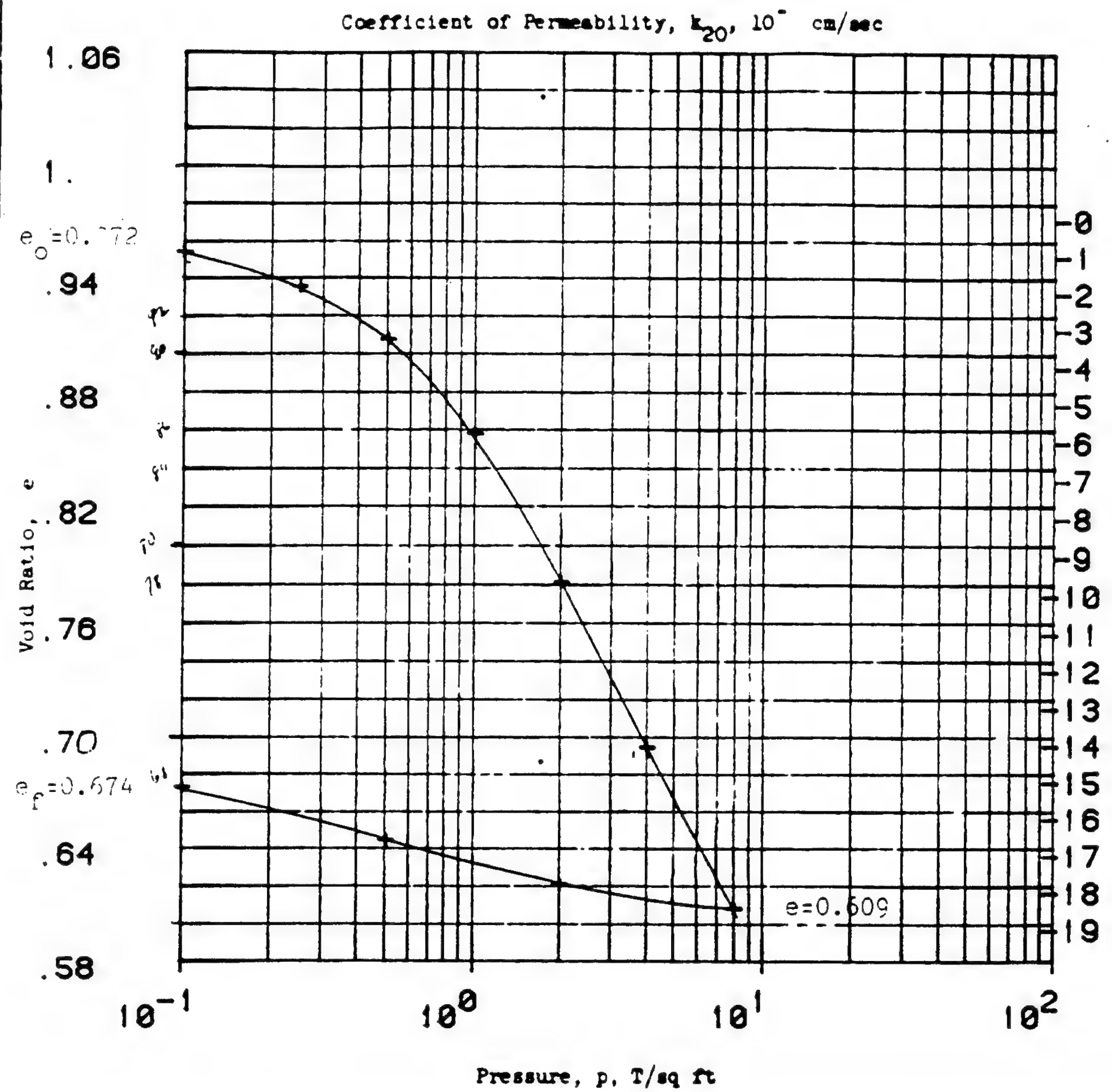
REMARKS Dark gray, soft consistency, high strength at PL, gloss shine, no shake response.

PROJECT	CHASKA NCS-IA-84-4-ED-GH
BORING NO 83-62	SAMPLE NO. 1
DEPTH ELEV	4.0-5.0
LABORATORY 84/84	DATE 10 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

Figure 10



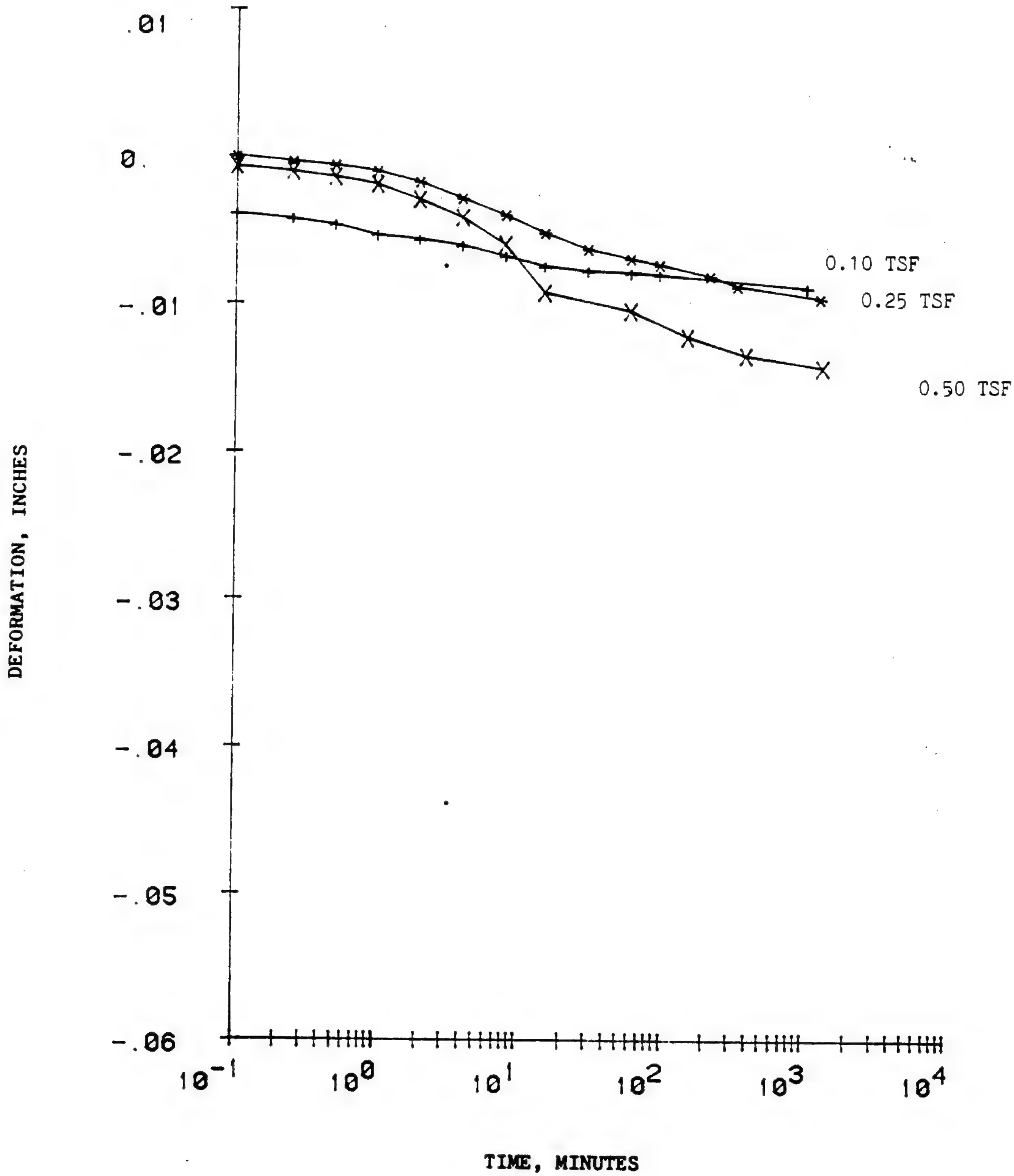
Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.29 in.	Ht 1. in.	Water Content, w_o	35.8 %	w_f	24.8 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	.97	e_f	.67
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	98. %	S_f	98. %
Compression Index, C_c		Dry Density, γ_d	84.2 lb/ft^3		
Classification Sandy clay, CL		k_{20} at e_o = x 10^{-} cm/sec			

LL 31	G_s 2.66
PL 14	D_{10}
Remarks	

Project CHASKA NCS-IA-84-4-ED-GH	
Area MRD LAB NO: 84/34	
Boring No. 83-62 MU	Sample No. S-2
Depth El 8.8-9.3	Date 8 FEB 1984

CONSOLIDATION TEST REPORT

Figure 8



PROJECT: CHASKA NCS-IA-84-4-ED-GH

MRD LAB NO: 84/34

DATE: 3 FEB 1984

BORING NO: 83-62 MU

SAMPLE NO: S-2

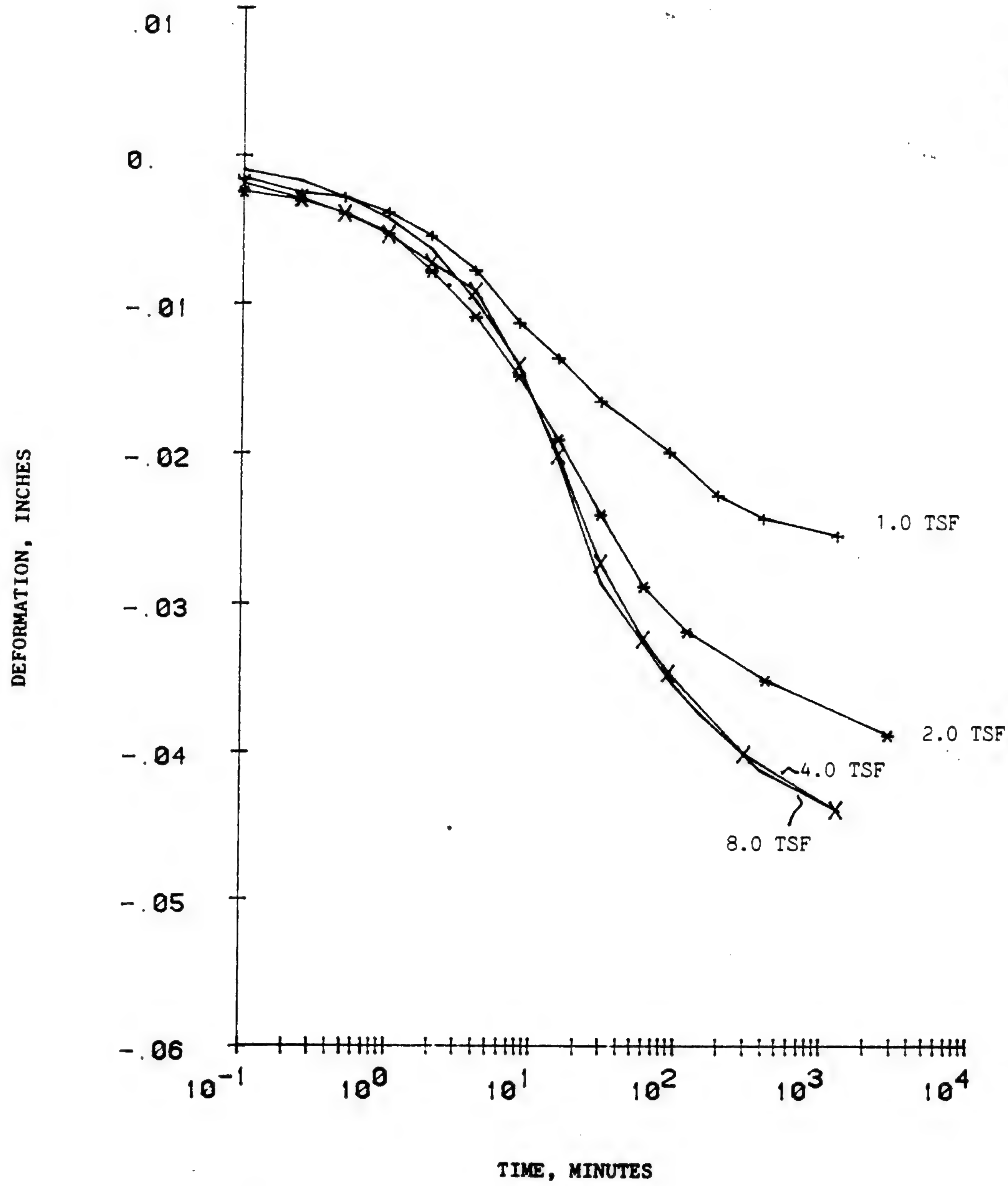
DEPTH/ELEV: 8.8-9.3

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 9

Figure C-139



PROJECT: CHASKA NCS-IA-84-4-ED-GH

MRD LAB NO: 84/34

DATE: 8 FEB 1984

BORING NO: 83-62 MU

SAMPLE NO: S-2

DEPTH/ELEV: 8.8-9.3

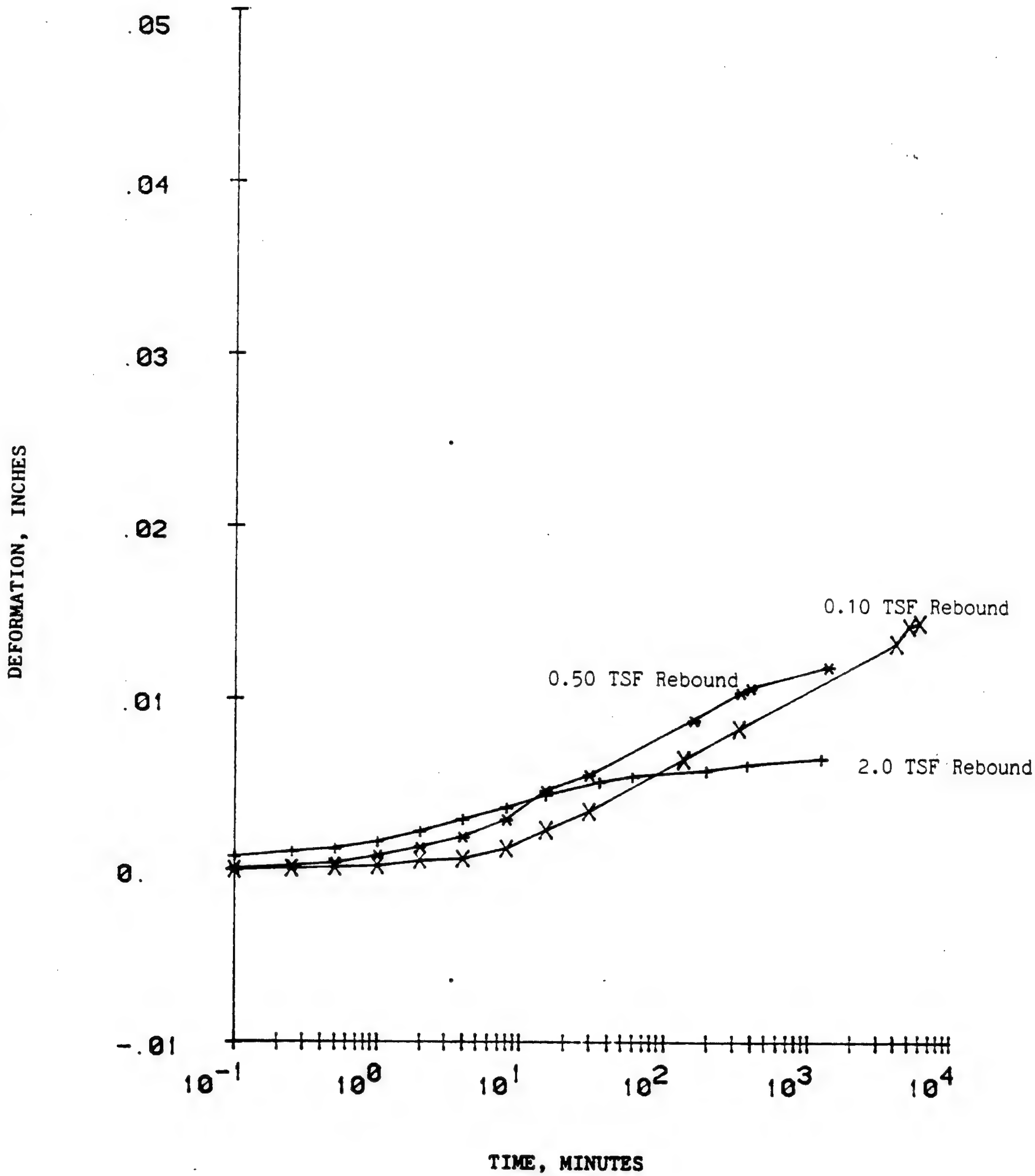
COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 10

Figure C-140

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-84-4-ED-GH

MRD LAB NO: 84/34

DATE: 3 FEB 1984

BORING NO: 83-62 MU

SAMPLE NO: S-2

DEPTH/ELEV: 8.8-9.3

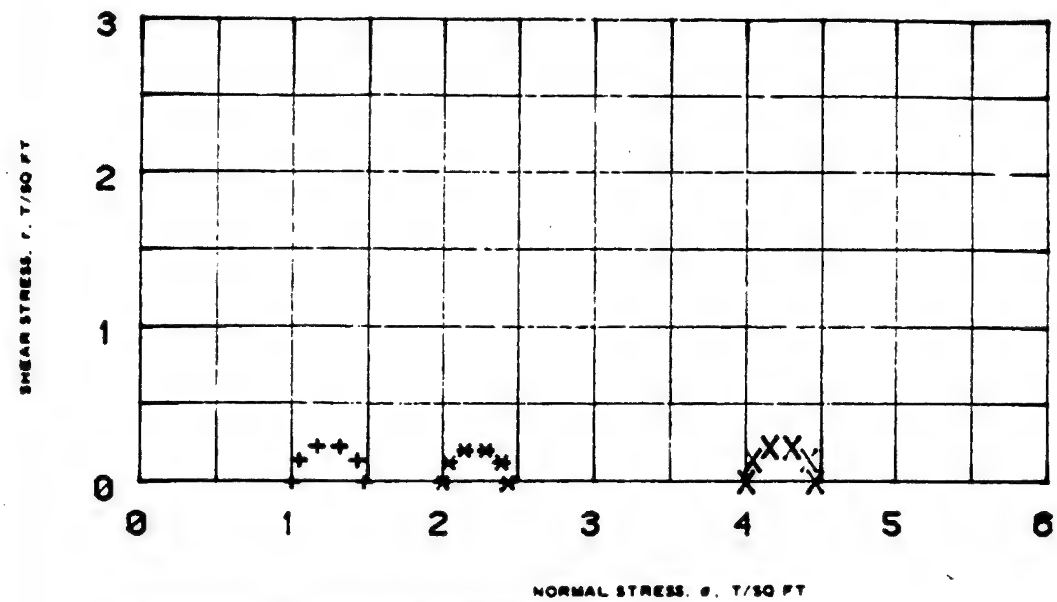
CONSOLIDATION TEST—TIME CURVES

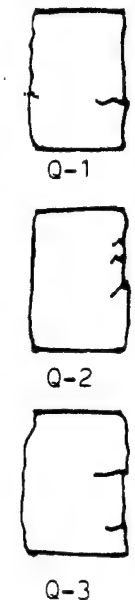
COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

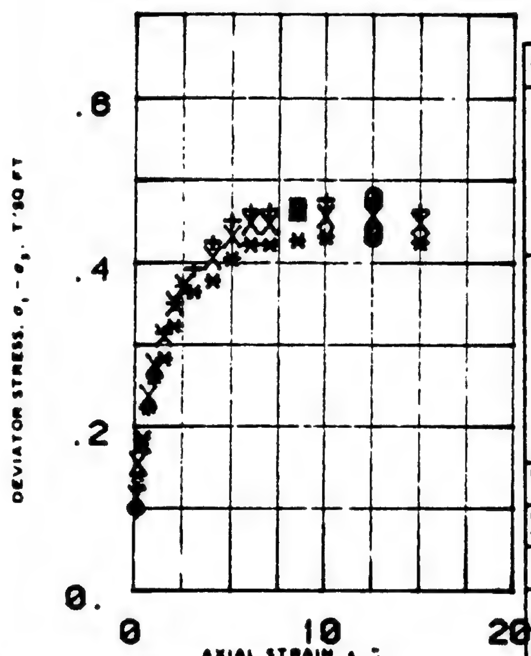
FIGURE: 11

Figure C-141

MRD Form 956, 1 May 80







SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	34.4	35.8	35.6	
	DRY DENSITY LB/CU FT	γ_{d_o}	87.9	86.5	86.6	
	SATURATION, %	S_o	100.	100.	100.	
	VOID RATIO	e_o	.89	.92	.92	
BEFORE SHEAR	WATER CONTENT, %	w_c	34.5	35.8	35.5	
	DRY DENSITY LB/CU FT	γ_{d_c}	87.9	86.5	86.6	
	SATURATION %	S_c	100.	100.	100.	
	VOID RATIO	e_c	.89	.92	.92	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.478	.434	.465	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	25	25	15	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.405	.425	.440	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.41	
INITIAL HEIGHT, IN		H_o	3.00	3.00	2.98	

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Sandy clay, CL

LL 31 | PL 14 | PI 17 | G_s 2.66

TYPE OF SPECIMEN UNDIST. | TYPE OF TEST Q

REMARKS: Dark gray, medium consistency, medium strength at PL, gloss shine, no shake response, random rust staining.

PROJECT CHASKA NCS-IA-84-4-ED-GH

BORING NO 83-62 | SAMPLE NO. 2

DEPTH ELEV 8.8-9.3

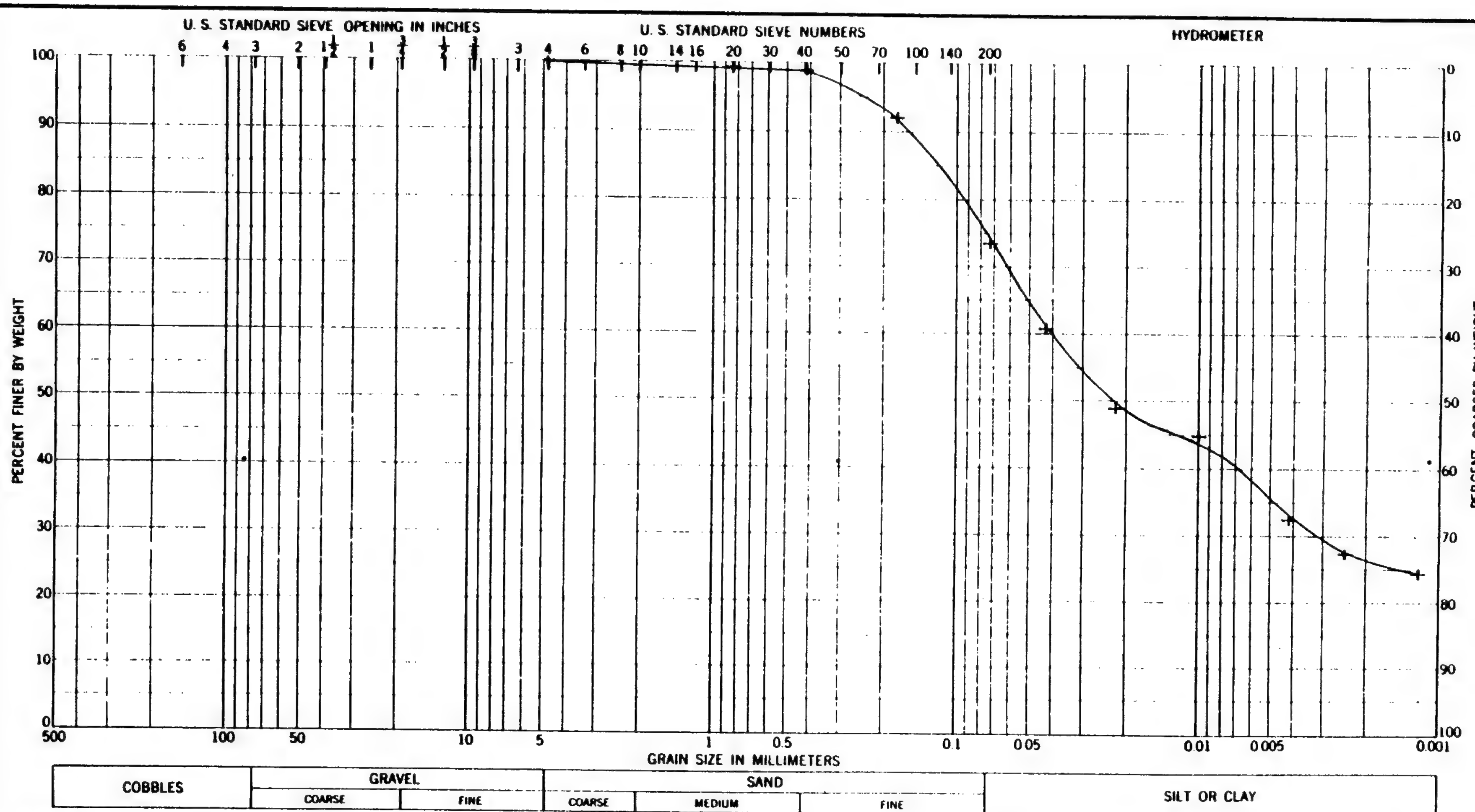
LABORATORY 84/84 | DATE 10 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

Figure 16

Figure C-142



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
S-2	8.8-9.3	Sandy clay, CL		31	14	17

Project: CHASKA NCS-IA-84-4-ED-GH

Area: MRD LAB NO. 84/35

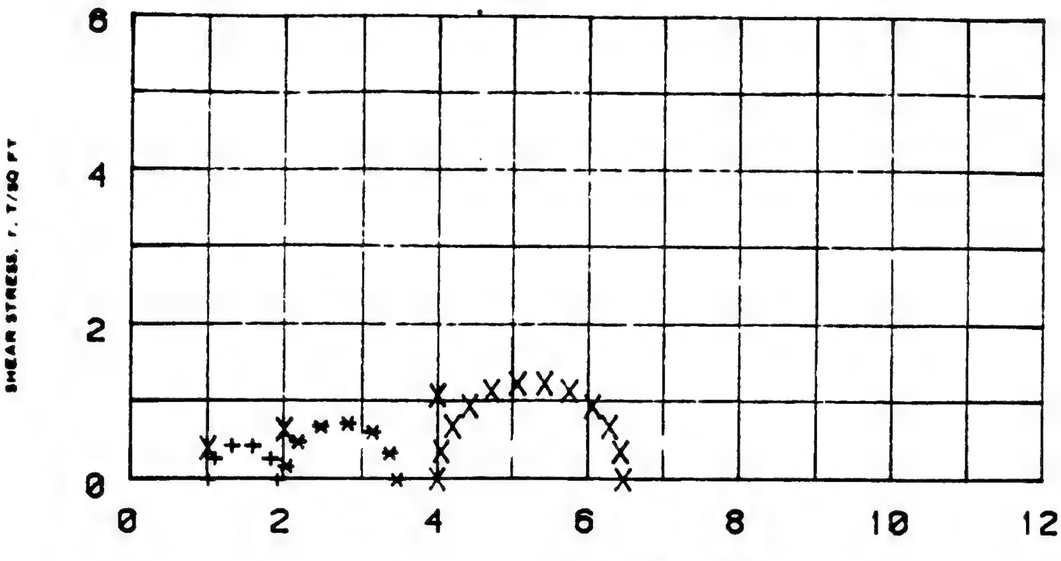
Boring No.: 83-62 MU

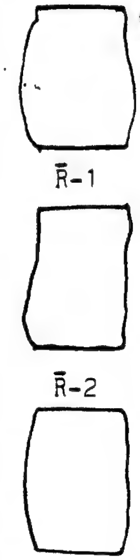
Date: 10 JAN 1984

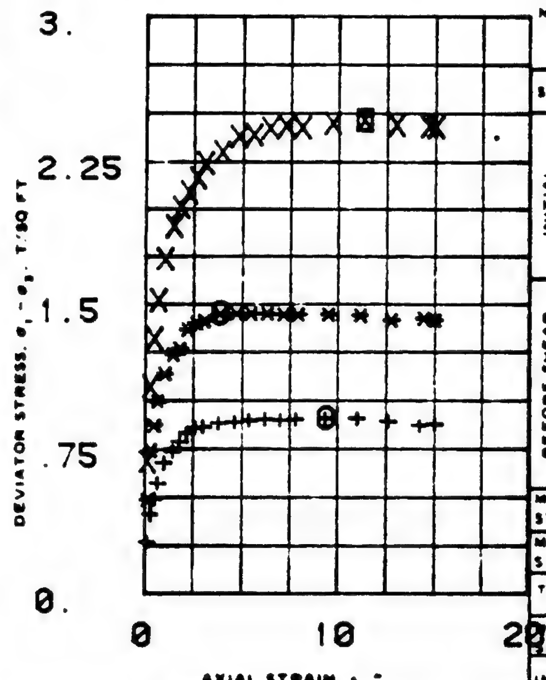
GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 17







SPECIMEN NO			1	2	3	
INITIAL	WATER CONTENT, %	w_o	36.8	38.8	37.1	
	DRY DENSITY LB/CU FT	γd_o	86.	86.5	84.8	
	SATURATION, %	S_o	100.	100.	100.	
	VOID RATIO	e_o	.96	.94	.96	
BEFORE SHEAR	WATER CONTENT, %	w_c	33.	30.7	27.1	
	DRY DENSITY LB/CU FT	γd_c	89.5	92.6	98.2	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	.86	.79	.69	
	FINAL BACK PRESSURE, T/SQ FT	u_o	2.7	2.7	2.7	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.911	1.46	2.47	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_1	720	500	840	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.875	1.42	2.46	
INITIAL DIAMETER, IN		D_o	1.42	1.42	1.41	
INITIAL HEIGHT, IN		H_o	2.99	2.98	2.99	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CL B value 1.00 0.99 1.00

LL 31 | PL 14 | PI 17 | Gs 2.68 | TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST $\bar{R}$

REMARKS

PROJECT CHASKA NCS-84-4-ED-GH

BORING NO 85-02 SAMPLE NO 2

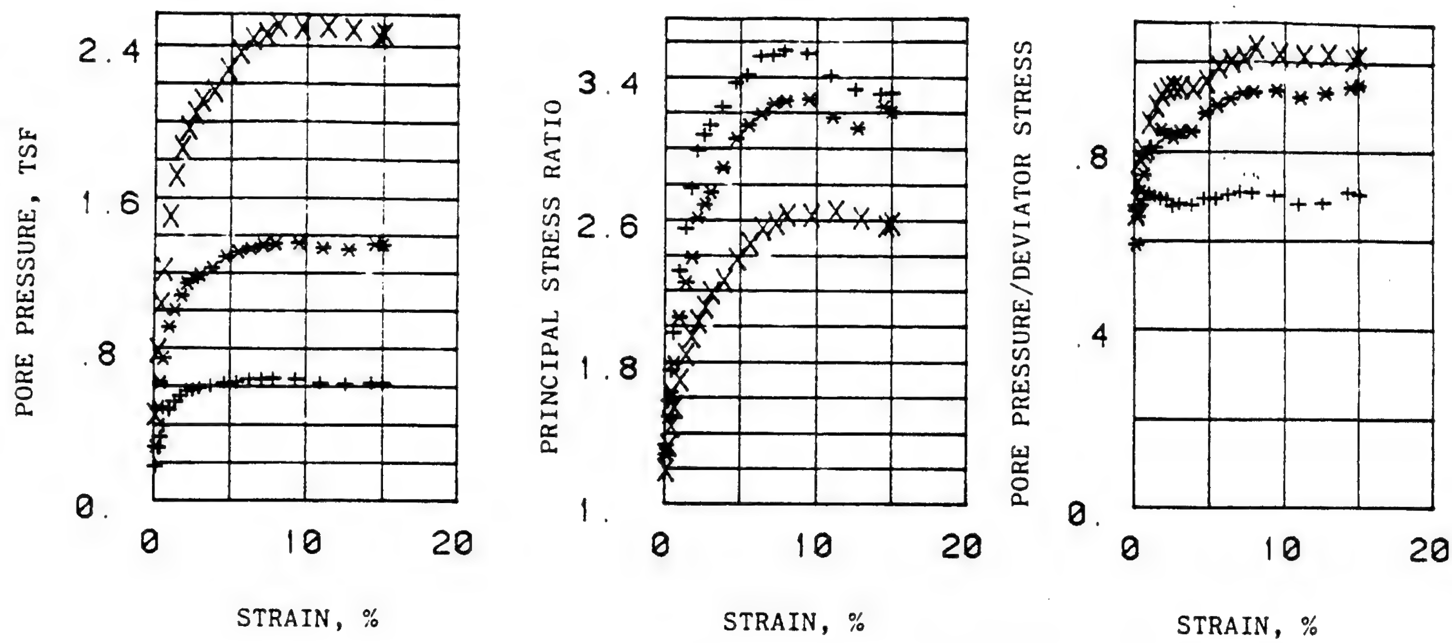
DEPTH ELEV 8.8-9.3

LABORATORY 84/54 DATE 8 FEB 1984

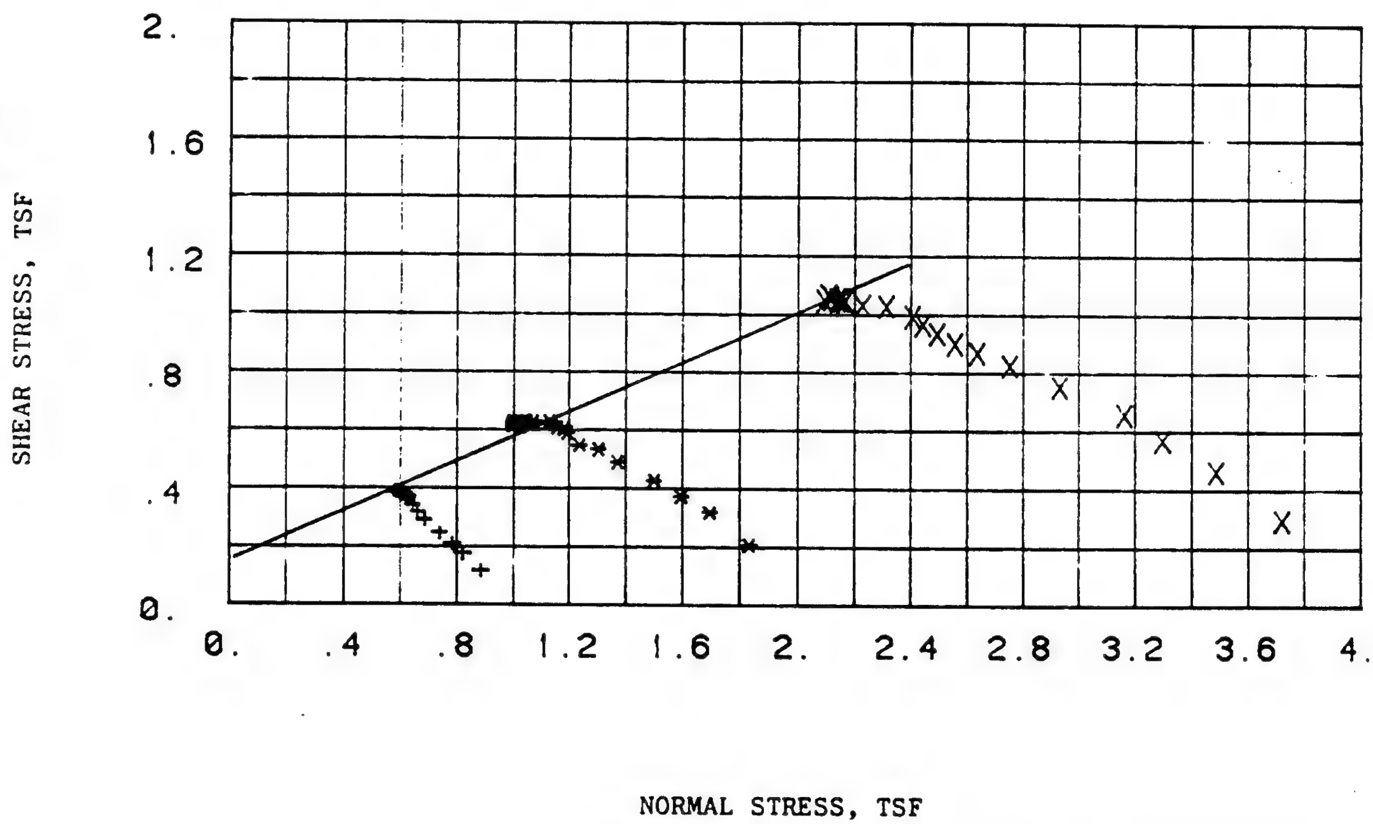
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 6



EFFECTIVE STRESS VECTOR CURVES ON 60. DEGREE PLANE



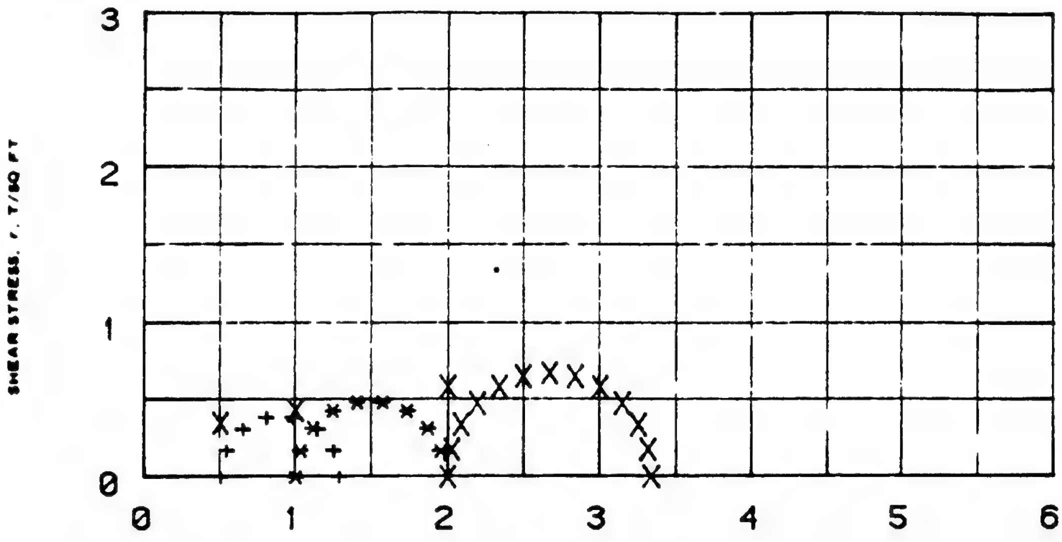
REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R̄ TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

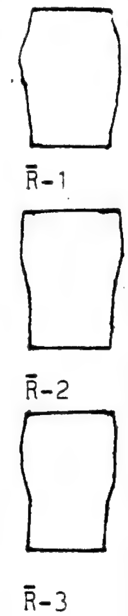
PROJECT: CHASKA NCS-84-4-ED-GH
BORING NO: 83-62 SAMPLE NO: 2
DEPTH/ELEV: 8.8-9.3
MRD LAB NO: 84/34 DATE: 3 FEB 1984

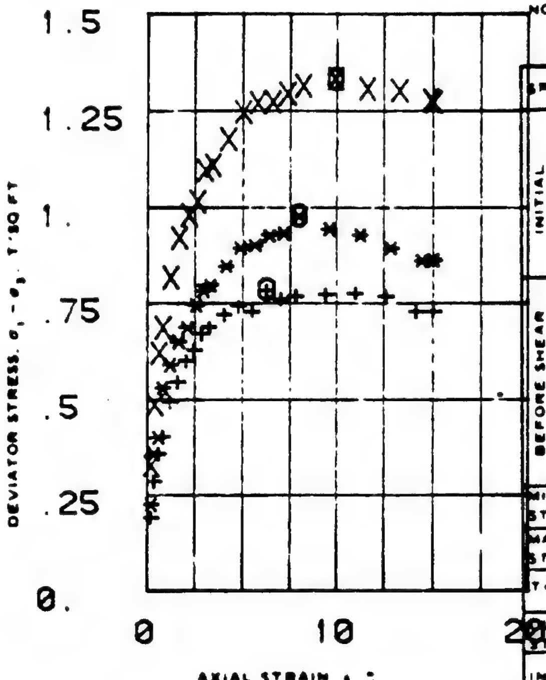
TRIAXIAL COMPRESSION TEST REPORT

MRD Form 756, 1 May 80

FIGURE: 7







			1	2	3	
SPECIMEN NO			1	2	3	
INITIAL	WATER CONTENT, %	w_o	72.3	75.2	81.5	
	DRY DENSITY LB/CU FT	γ_{d_o}	56.	54.0	51.9	
	SATURATION, %	S_o	99.	100.	100.	
	VOID RATIO	e_o	1.9	1.96	2.13	
BEFORE SHEAR	WATER CONTENT, %	w_c	67.3	63.5	58.9	
	DRY DENSITY LB/CU FT	γ_{d_c}	58.2	60.7	63.6	
	SATURATION, %	S_c	98.	99.	99.	
	VOID RATIO	e_c	1.79	1.67	1.56	
	FINAL BACK PRESSURE, T/SQ FT	u_o	1.94	1.94	1.94	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.780	.982	1.34	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_1	480	600	720	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.731	.884	1.27	
INITIAL DIAMETER, IN		D_o	1.4	1.4	1.4	
INITIAL HEIGHT, IN		H_o	3.	3.	3.	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Silt, MH

LL 57	PL 32	PI 25	G_s 2.8	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST R̄

REMARKS

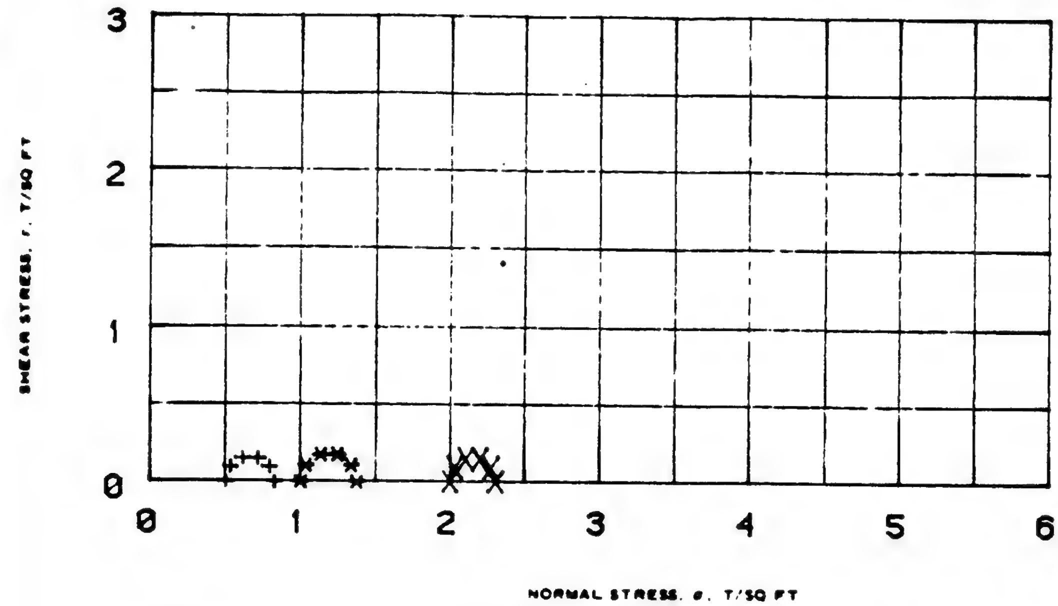
PROJECT	CHASKA NCS-IA-84-4-ED-GH
BORING NO 85-65	SAMPLE NO. 1
DEPTH ELEV	5.0-7.0
LABORATORY 84/34	DATE 11 JAN 1984

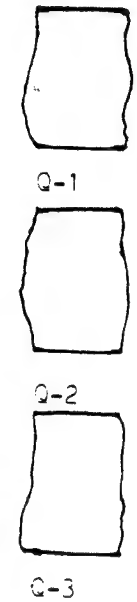
TRIAXIAL COMPRESSION TEST REPORT

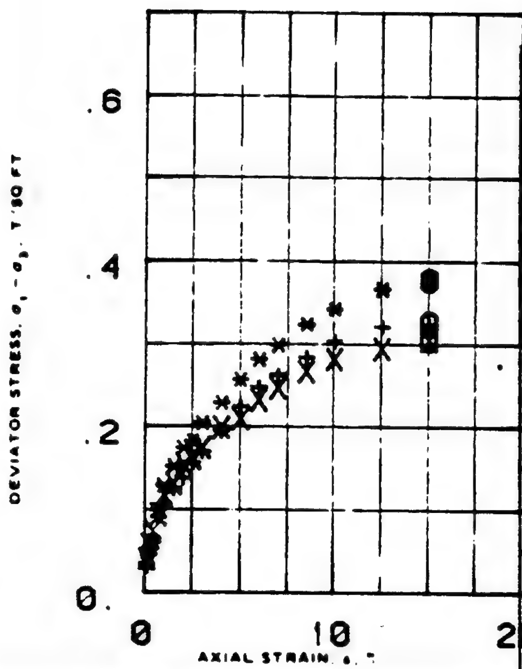
ENG FORM NO 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

Figure 15

Figure C-146







SPECIMEN NO			1	2	3	
INITIAL	WATER CONTENT, %	w_0	47.0	48.1	51.3	
	DRY DENSITY LB/CU FT	γd_0	73.7	73.3	71.6	
	SATURATION, %	S_0	100.	100.	100.	
	VOID RATIO	e_0	1.2	1.21	1.27	
BEFORE SHEAR	WATER CONTENT, %	w_c	47.0	47.9	51.	
	DRY DENSITY LB/CU FT	γd_c	73.7	73.3	71.6	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	1.2	1.21	1.27	
	FINAL BACK PRESSURE, T/SQ FT	u_0	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.326	.378	.386	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	27	27	29	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.326	.378	.388	
INITIAL DIAMETER, IN		D_0	1.39	1.4	1.41	
INITIAL HEIGHT, IN		H_0	2.97	2.96	2.93	

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Silt, MH

LL 57	PL 32	PI 25	G_s 2.8	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Dark gray with rust stains, soft consistency, low strength at PL, dull shine, fast shake response calcareous, possible organic content.

PROJECT CHASKA NCS-IA-84-4-ED-GH

BORING NO 83-63 SAMPLE NO 1

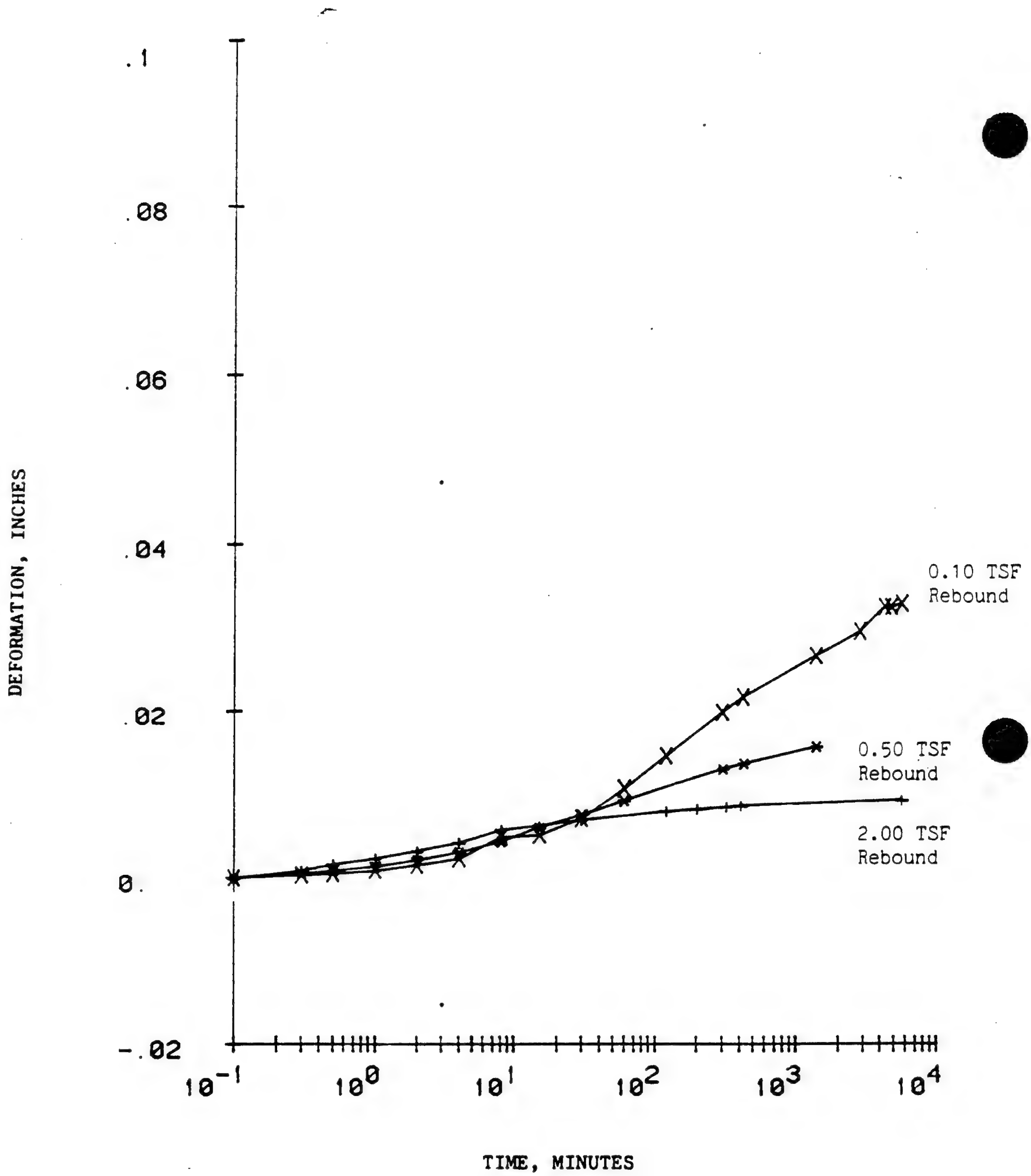
DEPTH ELEV 5.0-7.0

LABORATORY 84/34 DATE 11 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 14



PROJECT:	CHASKA	NCS-IA-84-4-ED-GH		
MRD LAB NO:	84/34		DATE:	3 FEB 1984
BORING NO:	83-63 MU	SAMPLE NO: S-1	DEPTH/ELEV:	5.0-7.0

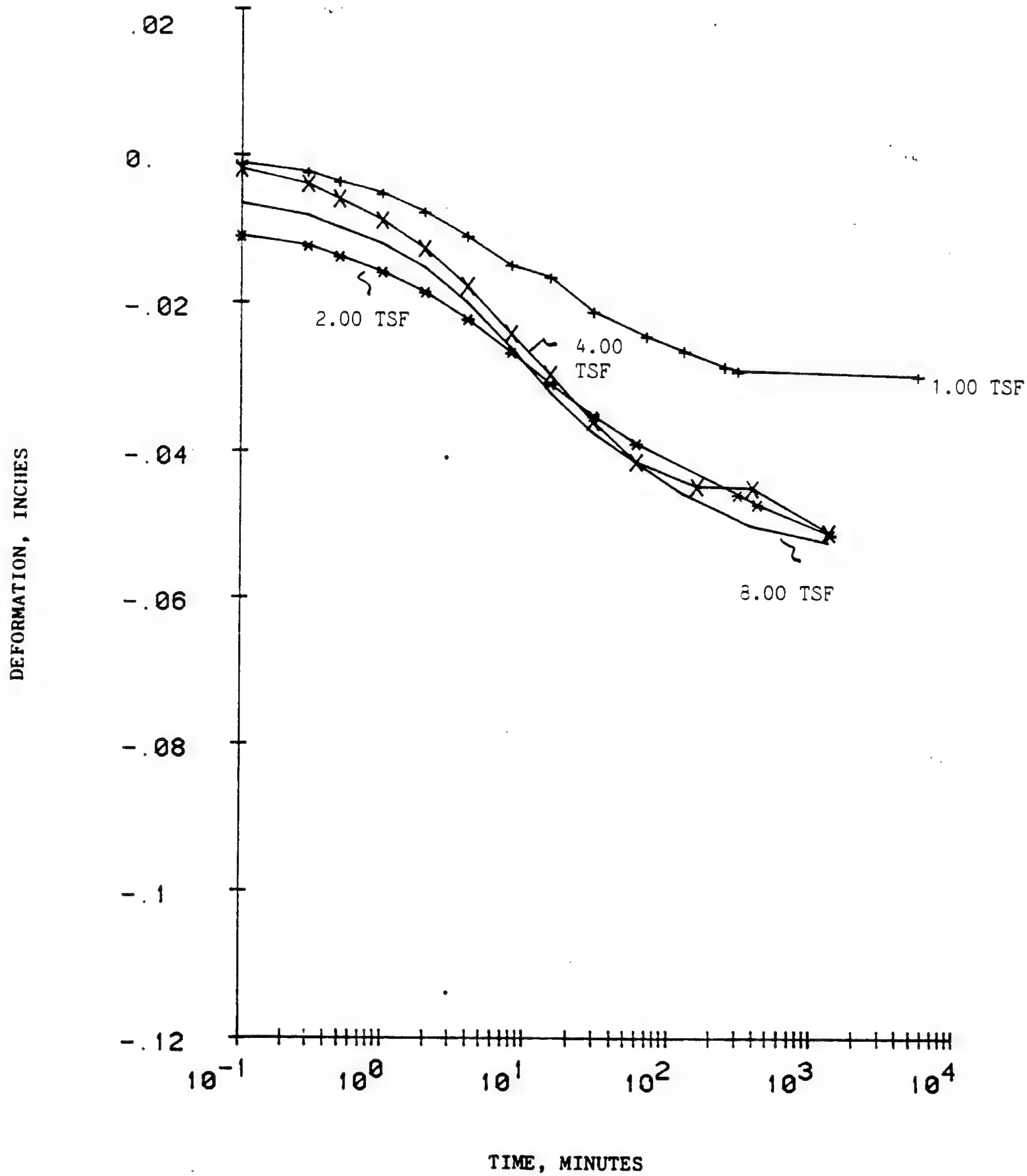
COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 15

Figure C-148

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-84-4-ED-GH

MRD LAB NO: 84/34 DATE: 3 FEB 1984

BORING NO: 83-63 MU SAMPLE NO: S-1 DEPTH/ELEV: 5.0-7.0

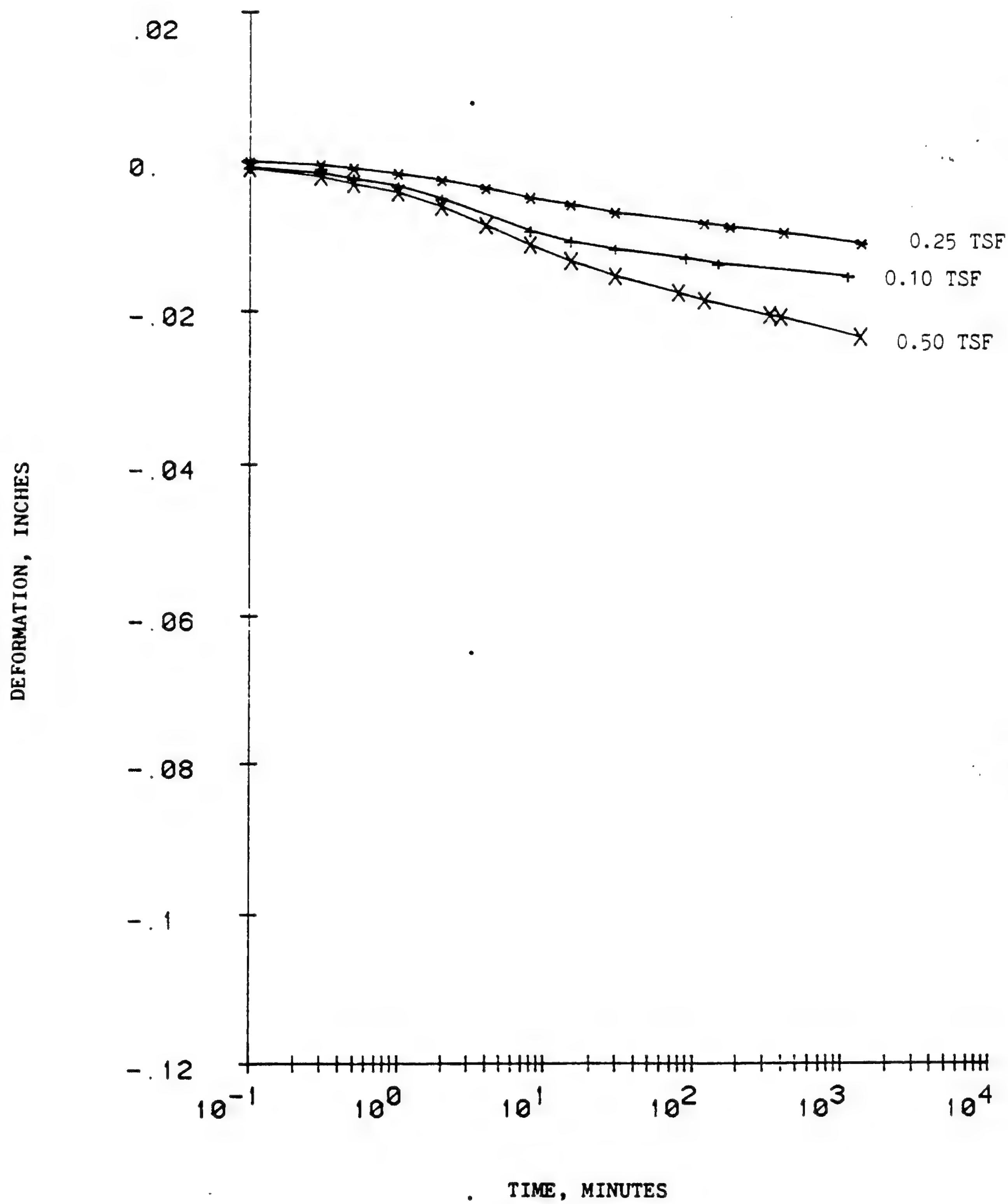
COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 14

Figure C-149

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-84-4-ED-GH

MRD LAB NO: 84/34 DATE: 3 FEB 1984

BORING NO: 83-63 MU SAMPLE NO: S-1 DEPTH/ELEV: 5.0-7.0

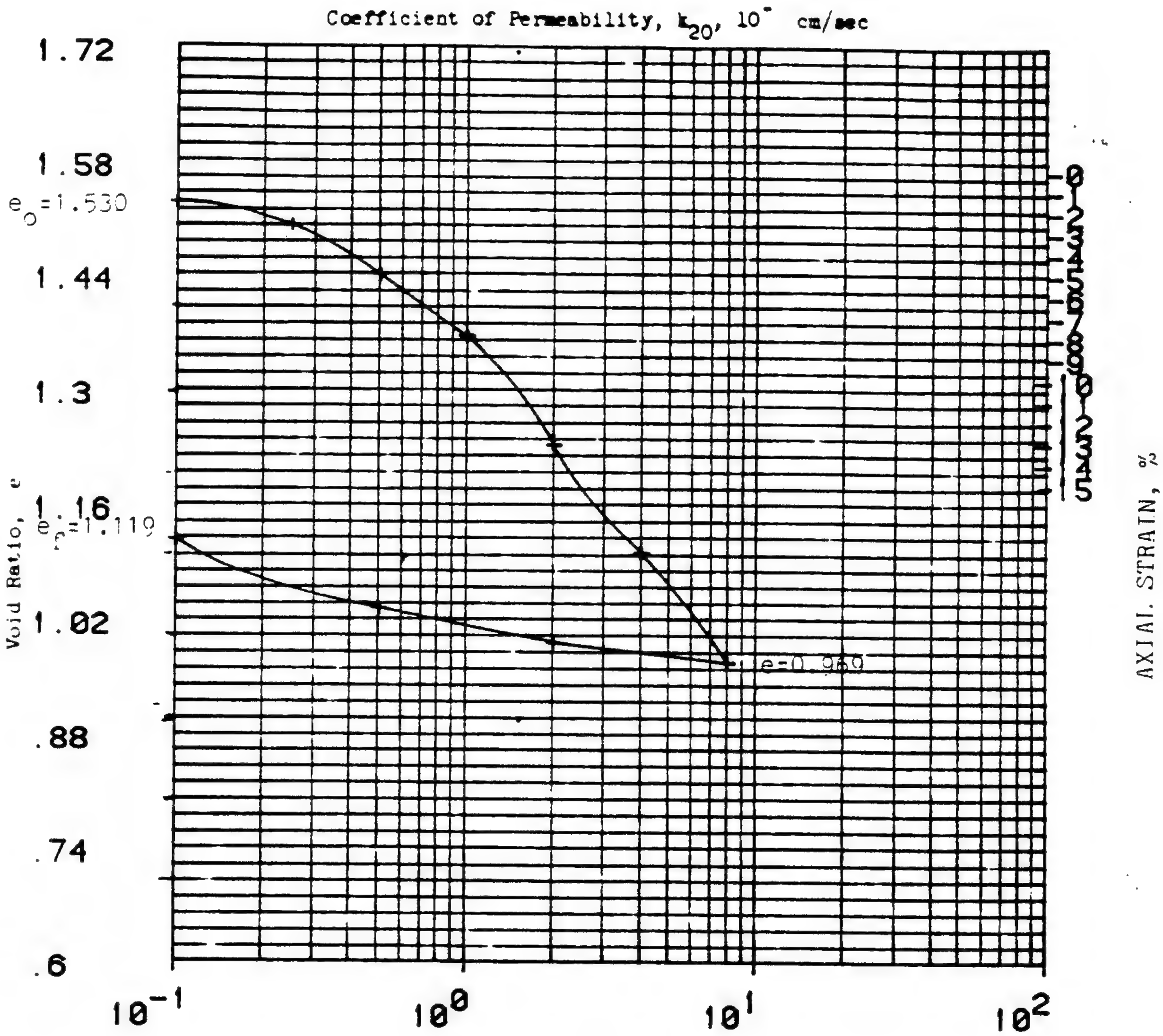
<u>CONSOLIDATION TEST—TIME CURVES</u>

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 13

Figure C-150

MRD Form 956, 1 May 80

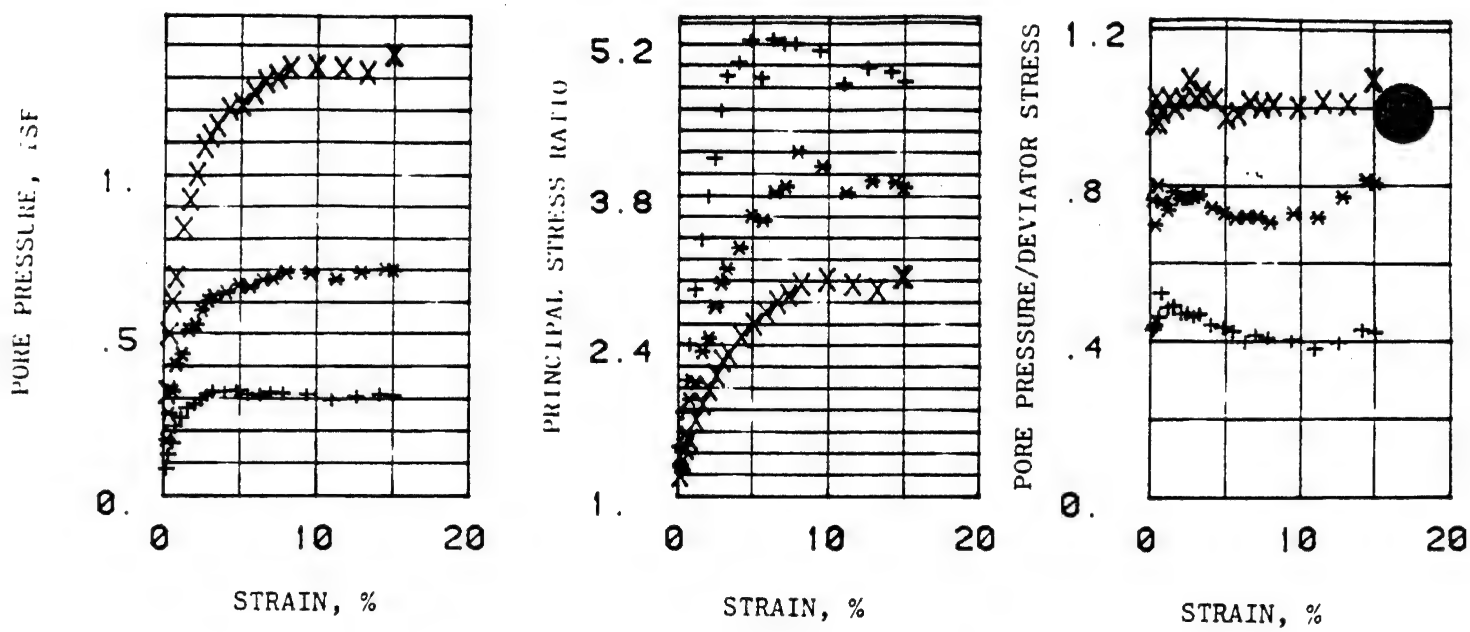


Type of Specimen UNDISTURBED		Before Test		After Test
Diam 4.29 in.	Ht 1. in.	Water Content, w_o	59.6 %	w_f 40.8 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.57	e_f 1.12
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	99. %	S_f 95. %
Compression Index, C_c		Dry Density, γ_d	63.1 lb/ft^3	
Classification Silt, MH		k_{20} at e_o = × 10ˉ cm/sec		
LL 57	G_s 2.6	Project CHASKA NCS-IA-84-4-ED-GH		
PL 32	D_{10}			
Remarks		Area MRO LAB NO: 84/34		
		Boring No. 83-63 MU		Sample No. S-1
		Depth El 5.0-7.0		Date 3 FEB 1984
		CONSOLIDATION TEST REPORT		

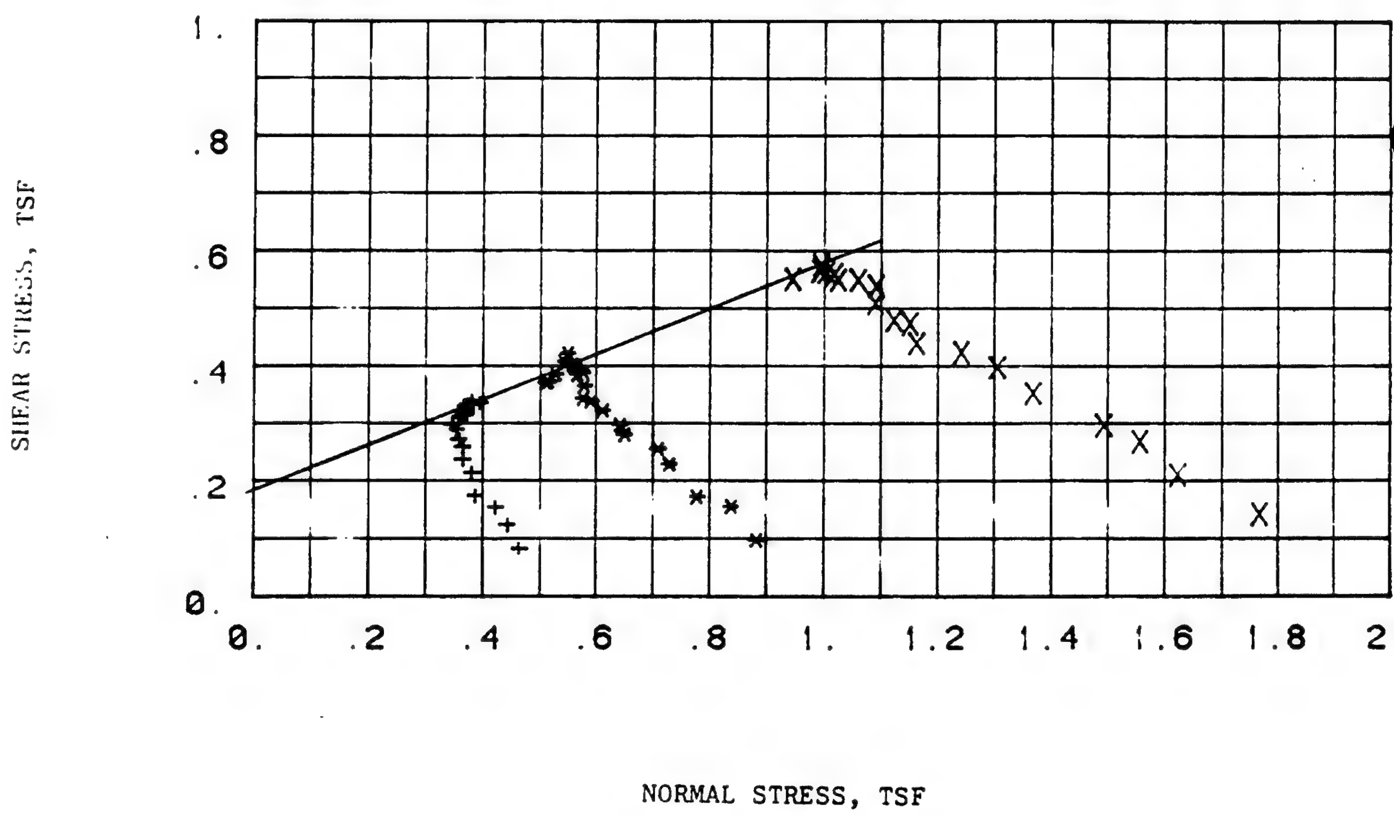
ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 12

Figure C-151



EFFECTIVE STRESS VECTOR CURVES ON 60. DEGREE PLANE



REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R̄ TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

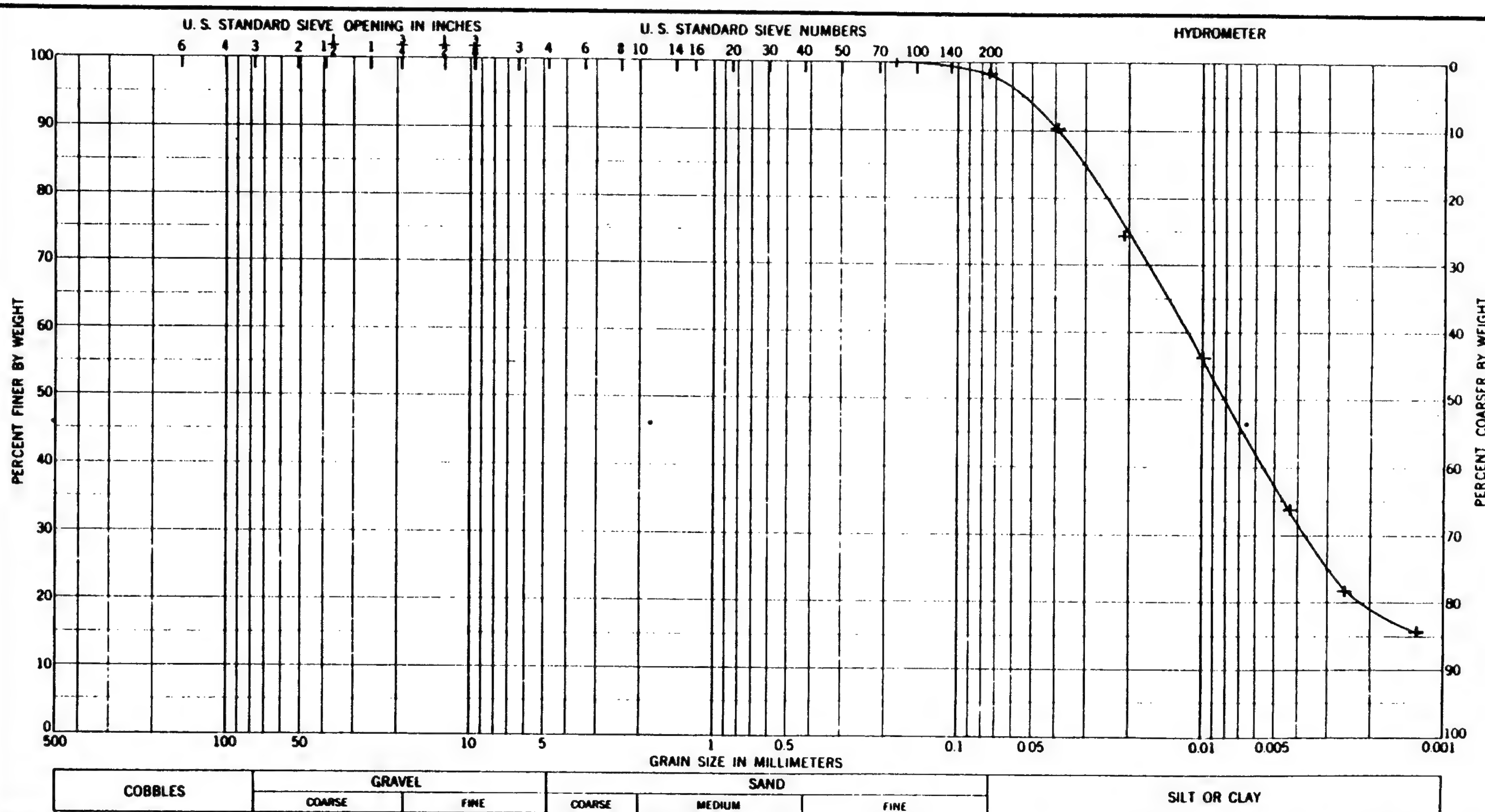
PROJECT:	CHASKA NCS-IA-84-4-ED-GH		
BORING NO:	83-05	SAMPLE NO:	1
DEPTH/ELEV:	5.0-7.0		
MRD LAB NO:	84/54	DATE:	11 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 16

MRD Form 756, 1 May 80

Figure C-15



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	5.0-7.0	Silt, MH		57	32	25

Project: CHASKA NCS-IA-84-4-ED-GH

Area: MRD LAB NO. 84/54

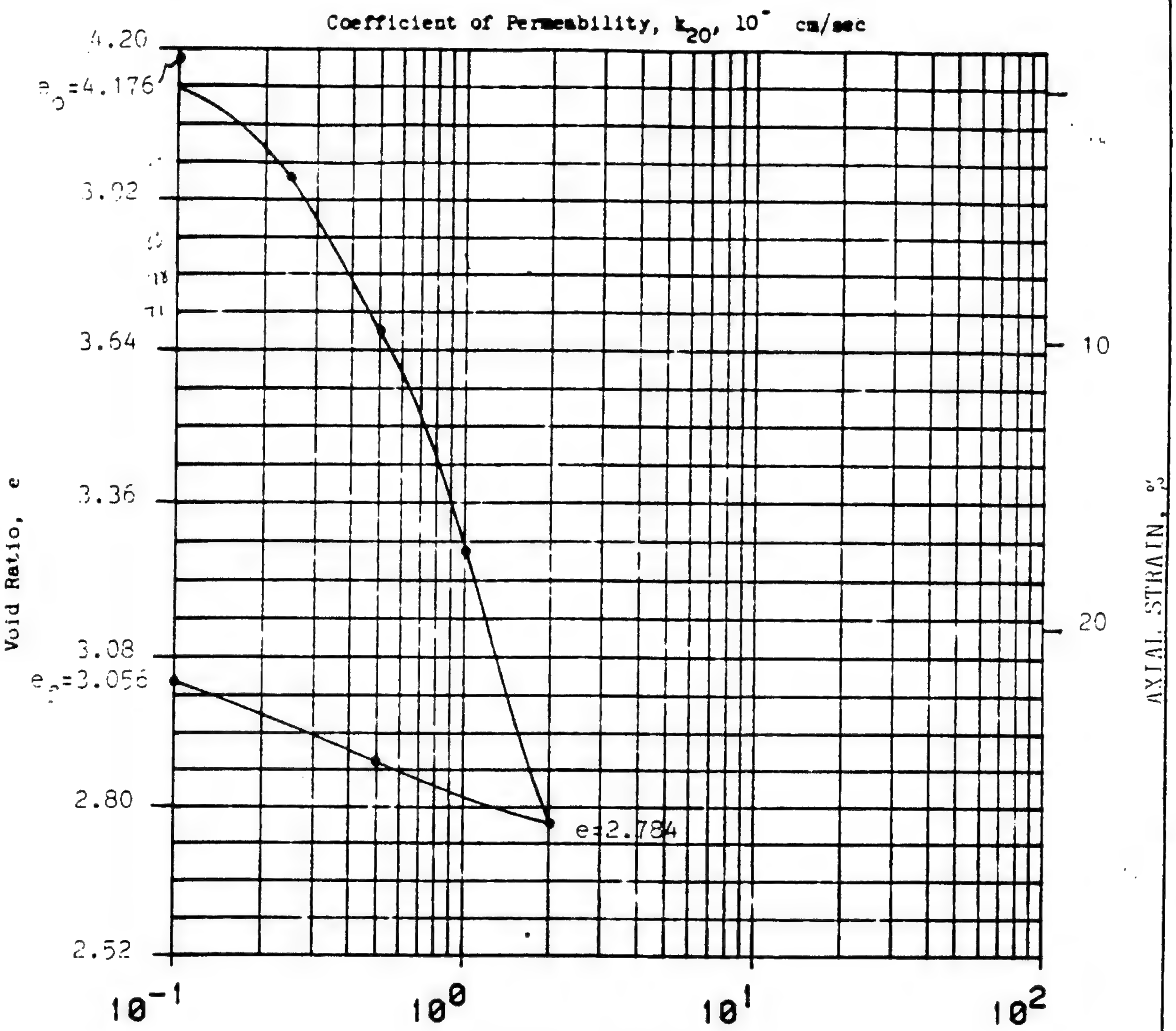
Boring No. 83-63

Date: 11 JAN 1984

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 17



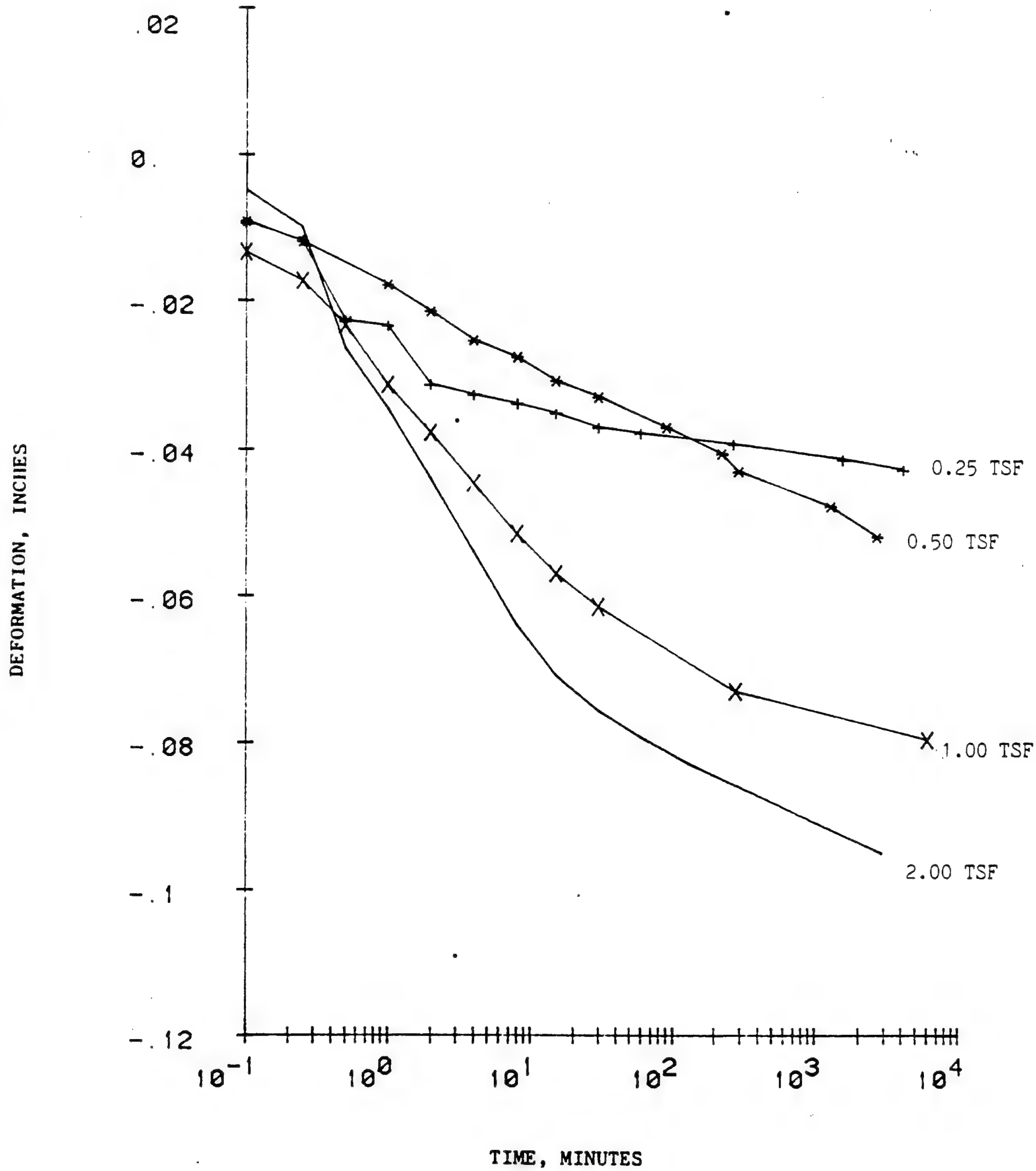
Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.29 in.	Ht 1. in.	Water Content, w_o	181. %	w_f	136. %
Overburden Pressure, Po T/sq ft		Void Ratio, e_o	4.18	e_f	3.06
Preconsol. Pressure, Pc T/sq ft		Saturation, S_o	98. %	S_f	100. %
Compression Index, C_c		Dry Density, γ_d	27.1 lb/ft^3		
Classification Organic, OH		k_{20} at e_o = x 10^{-} cm/sec			
LL 182	G_s 2.25	Project CHASKA NCS-IA-84-4-ED-GH			
PL 93	D_{10}				
Remarks The change in height exceeded travel in test apparatus so the specimen was rebounded from 2.0 TSF.		Area MRD LAB NO: 84/34			
		Boring No. 83-63 MU		Sample No. S-2	
		Depth El 13.0-15.0		Date 3 FEB 1984	

CONSOLIDATION TEST REPORT

ENG FORM 2090 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE.

Figure C-154

Figure 18



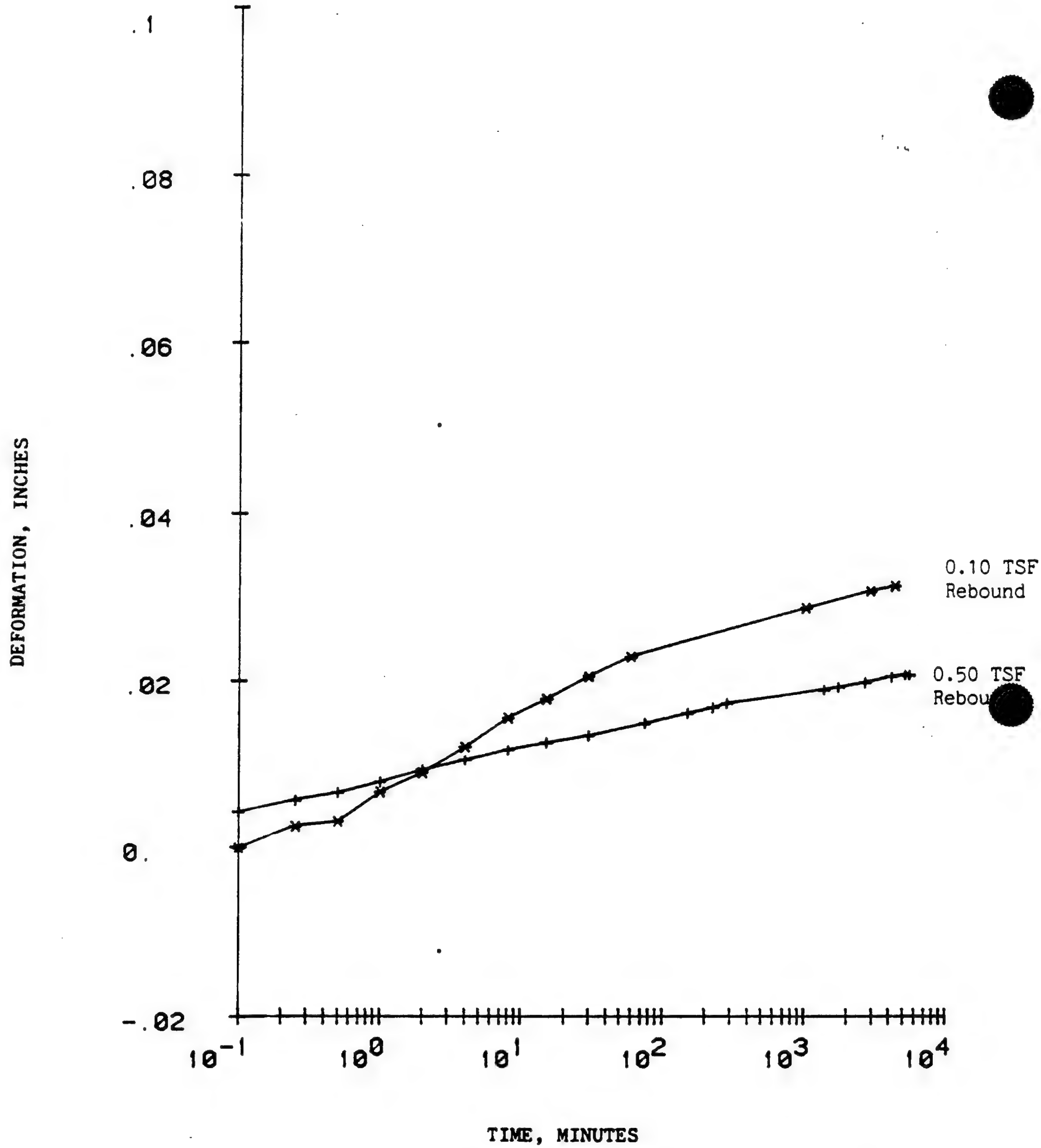
PROJECT:	CHASKA NCS-IA-84-4-ED-GH				
MRD LAB NO:	84/34			DATE:	3 FEB 1984
BORING NO:	83-63 MU	SAMPLE NO:	S-2	DEPTH/ELEV:	13.0-15.0

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST--TIME CURVES

FIGURE: 19

Figure C-155



PROJECT: CHASKA NCS-IA-84-4-ED-GH

MRD LAB NO: 84/34

DATE: 3 FEB 1984

BORING NO: 83-63 MU

SAMPLE NO: S-2

DEPTH/ELEV: 13.0-15.0

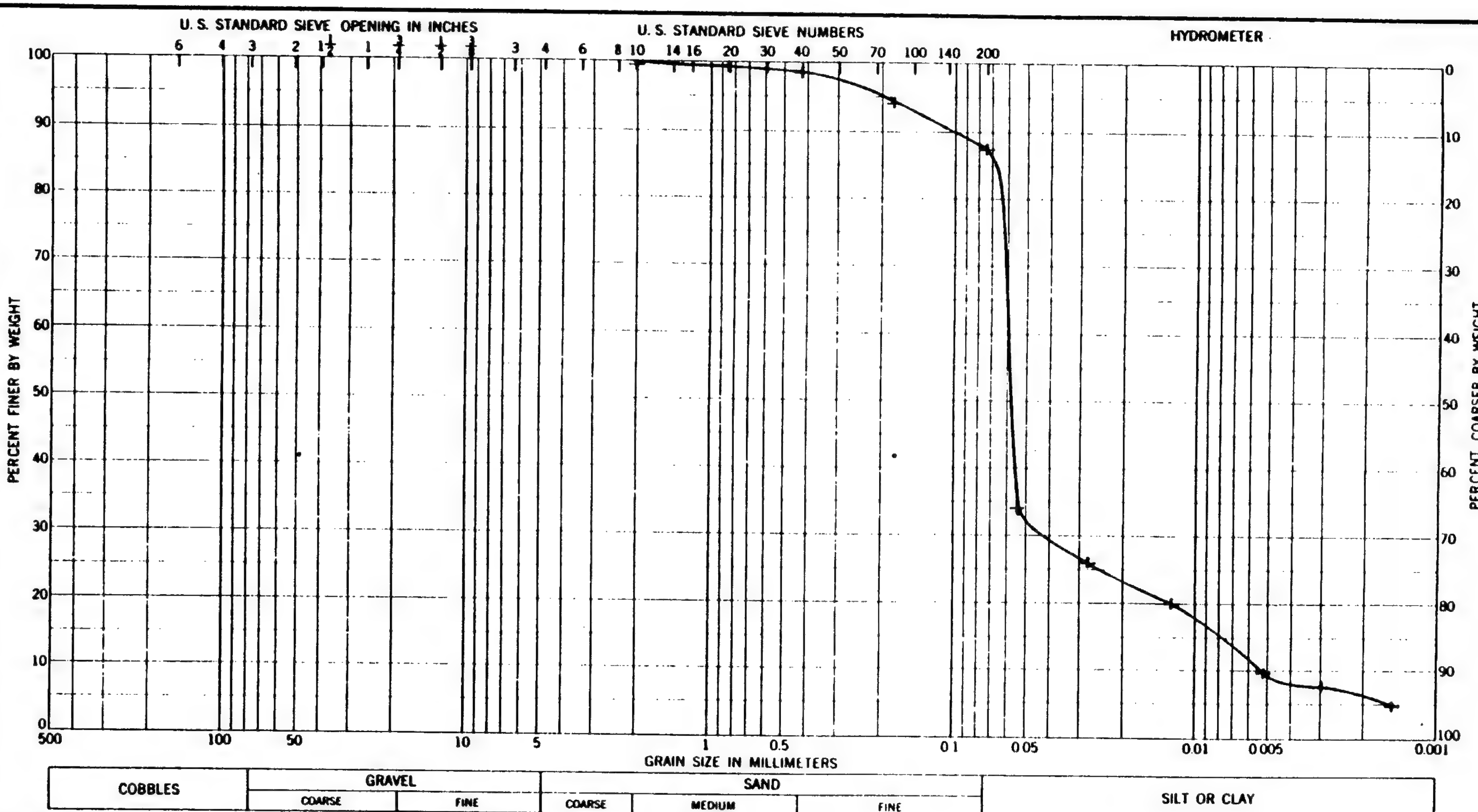
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 20

Figure C-156

MRD Form 956, 1 May 80



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	13.0-15.0	Organic, OH		182	93	89

Project CHAKSA NCS-IA-84-4-EJ-GH

Area MRD LAB NO. 84/34

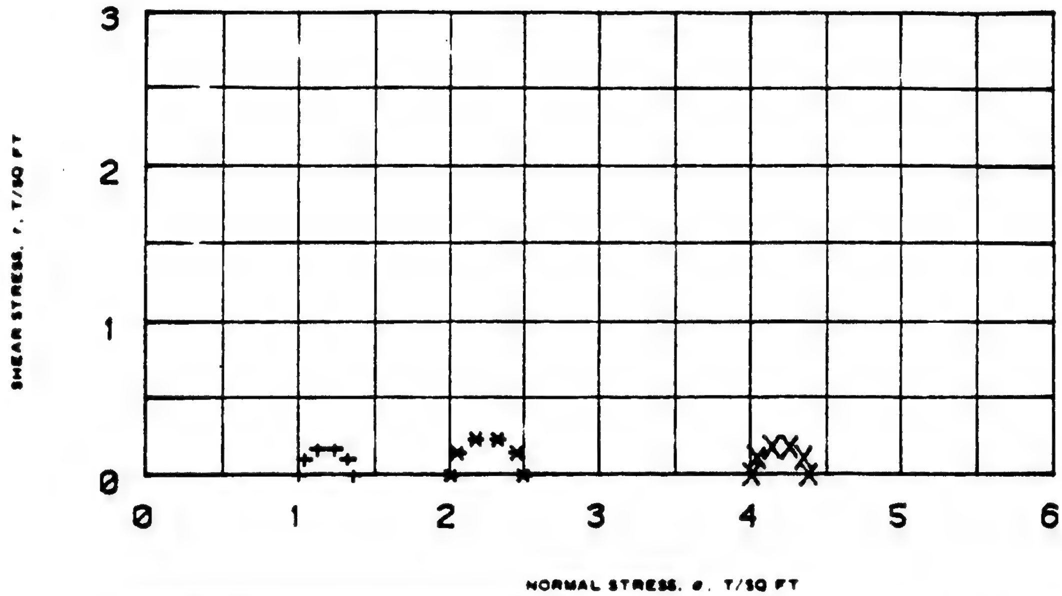
Boring No. 83-83

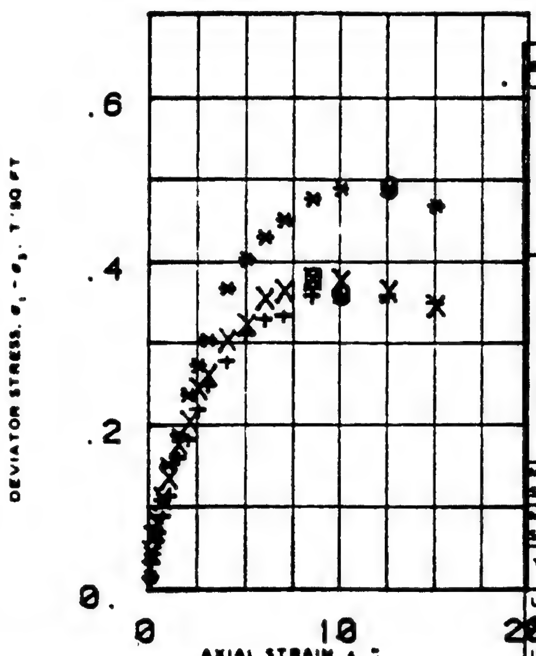
Date 27 DEC 1983

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 31





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	181.	167.	175.	
	DRY DENSITY LB/CU FT	γ_{d_o}	26.0	28.5	28.1	
	SATURATION, %	S_o	96.	96.	97.	
	VOID RATIO	e_o	4.25	3.92	4.01	
BEFORE SHEAR	WATER CONTENT, %	w_c	180.	166.	175.	
	DRY DENSITY LB/CU FT	γ_{d_c}	27.	29.1	28.5	
	SATURATION, %	S_c	97.	98.	99.	
	VOID RATIO	e_c	4.2	3.85	3.92	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.56	.491	.38	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	20	24	14	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.35	.47	.348	
INITIAL DIAMETER, IN		D_o	1.4	1.4	1.39	
INITIAL HEIGHT, IN		H_o	2.98	2.95	2.95	

CONTROLLED- Strain TEST

DESCRIPTION OF SPECIMENS Organic, OH

LL 182	PL 93	PI 89	G 2.25	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Light to dark gray, soft consistency, low strength at PL, no shine, no shake response.

PROJECT CHASKA NCS-IA-04-4-ED-GH

BORING NO 83-63 | SAMPLE NO. 2

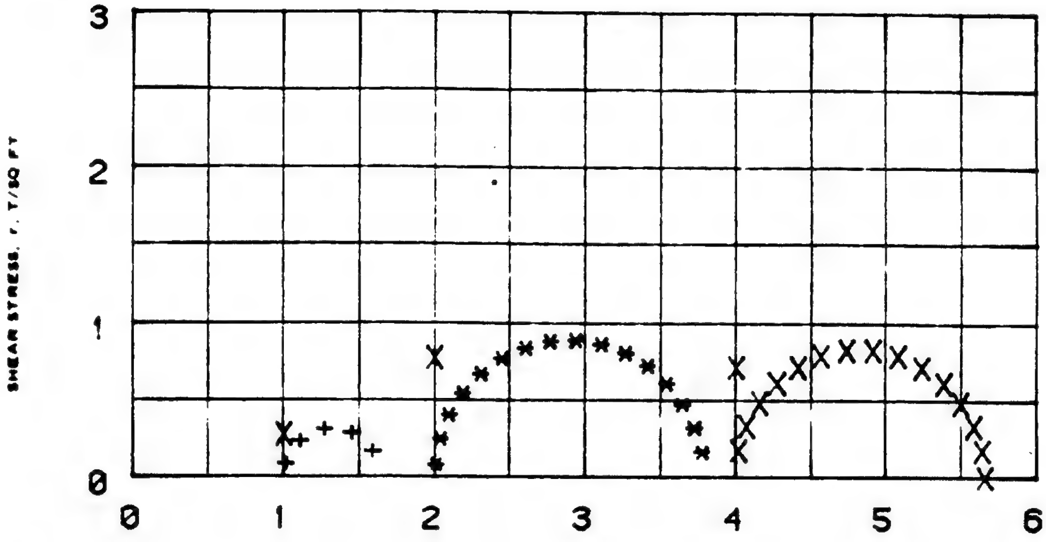
DEPTH ELEV 13.0-15.0

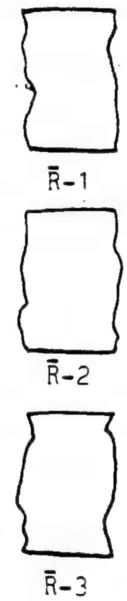
LABORATORY 04/34 | DATE 07 DEC 1983

TRIAXIAL COMPRESSION TEST REPORT

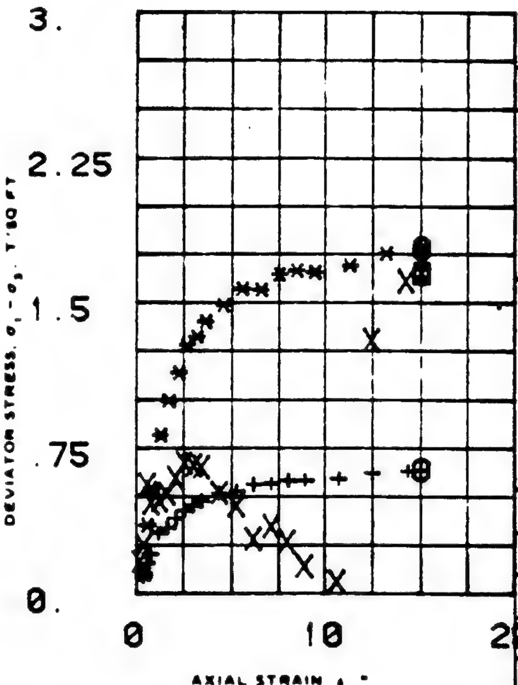
ENG FORM NO 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIgure 30





NORMAL STRESS, σ, T/SQ FT



SPECIMEN NO			1	2	3	
INITIAL	WATER CONTENT, %	w_o	171.	164.	161.	
	DRY DENSITY LB/CU FT	γ_{d_o}	28.9	44.6	38.2	
	SATURATION, %	S_o	100.	100.	100.	
	VOID RATIO	e_o	3.87	2.17	3.66	
BEFORE SHEAR	WATER CONTENT, %	w_c	122.	96.4	88.1	
	DRY DENSITY LB/CU FT	γ_{d_c}	41.1	70.8	42.7	
	SATURATION, %	S_c	100.	100.	79.	
	VOID RATIO	e_c	2.42	.70	2.29	
	FINAL BACK PRESSURE, T/SQ FT	u_o	2.7	2.7	2.7	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.641	1.70	1.66	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1002	955	1010	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.641	1.70	1.66	
INITIAL DIAMETER, IN		D_o	1.42	1.18	1.41	
INITIAL HEIGHT, IN		H_o	2.96	3.	2.98	

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS Organic, OH

LL 132	PL 93	PI 89	G_s 2.25	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST R̄

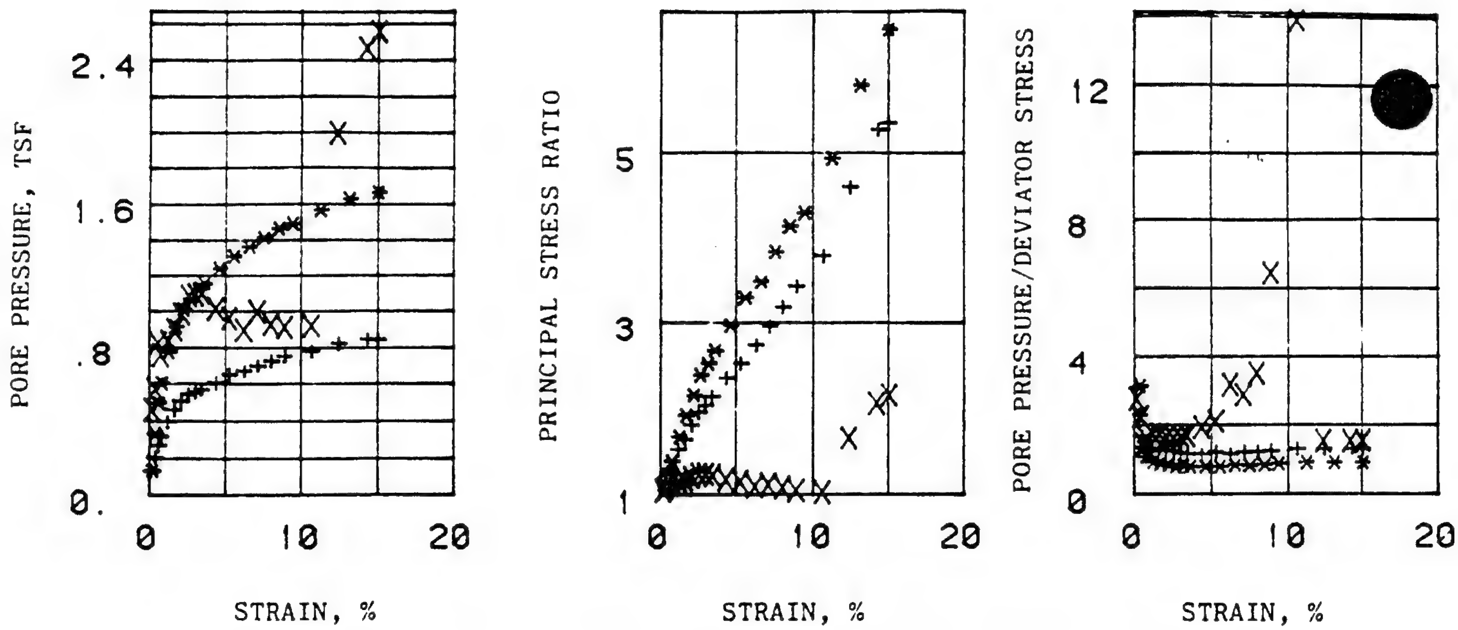
REMARKS These are results of testing on organic material with numerous roots and wood. Densities and strengths are extremely variable.

PROJECT	CHASKA NCS-IA-84-4-ED-GH
BORING NO 85-85MN	SAMPLE NO. 2
DEPTH ELEV 13-15	
LABORATORY 84/84	DATE 3 FEB 1984

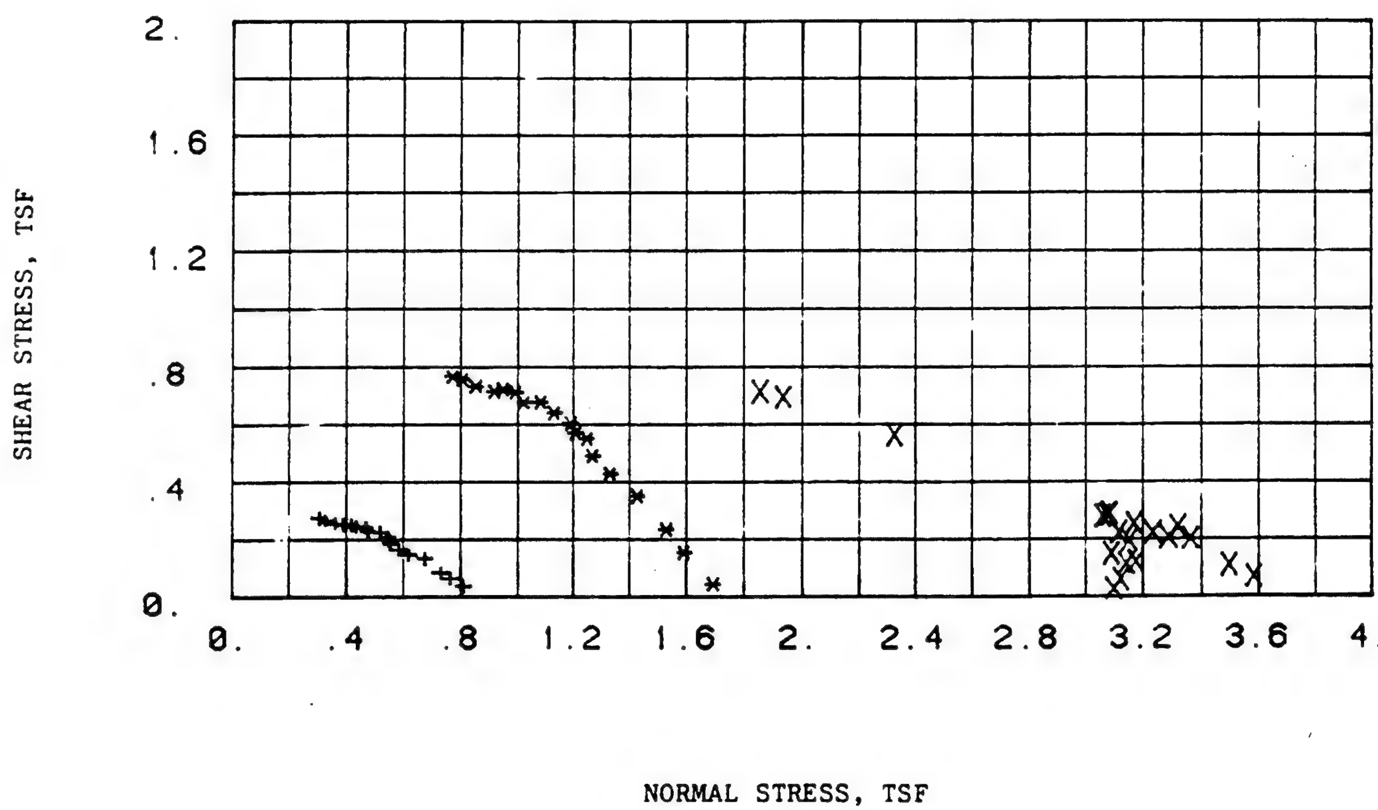
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)*
REV JUNE 1970

Figure 16



EFFECTIVE STRESS VECTOR CURVES ON 60. DEGREE PLANE



REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R̄ TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

PROJECT: CHASKA NCS-IA-84-4-ED-GH
BORING NO: 83-83MN SAMPLE NO: 2
DEPTH/ELEV: 13-15
MRD LAB NO: 84/34 DATE: 8 FEB 1984

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 17

MRD Form 756, 1 May 80

Figure C-1

TRIAXIAL TEST DATA

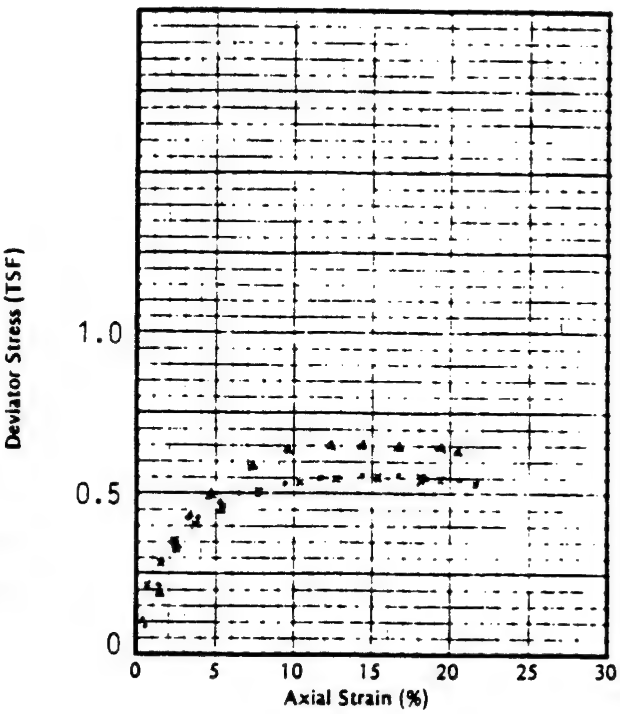
Date March 3, 1988 Job No. 4220 88-226

Project Chaska Creek Diversion

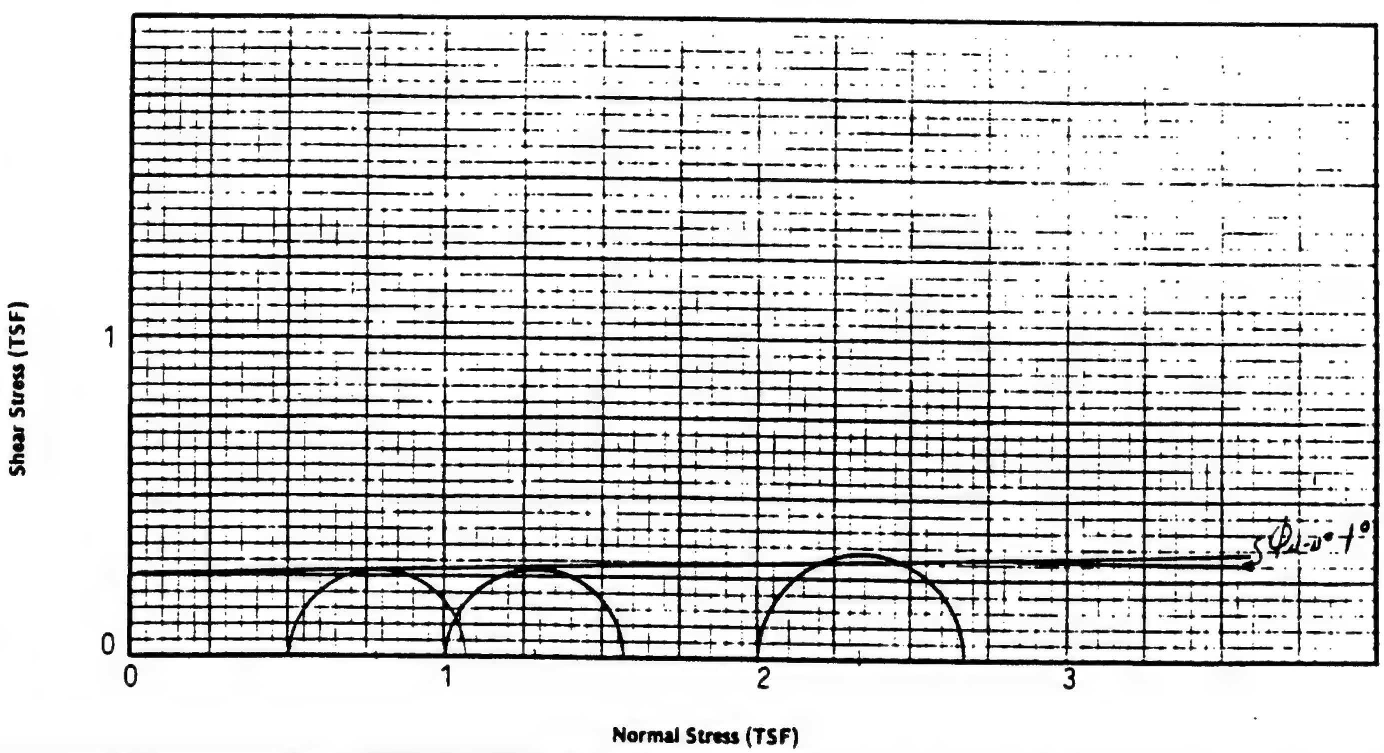
Boring No. 87-72M Sample No. 1 Depth (ft) 4-6 Type of Sample 5T

Soil Type Organic Clay (OH) Type of Test U-U

Remarks: Specimens trimmed to given sizes; lucite discs placed on each end; all drainage valves closed; stressed to given strains at constant rate of 0.060"/min.; Mohr circles at maximum deviator stress.



SPECIMEN NO.		A	B	C
Initial	Diameter (inches)	1.97	1.97	1.98
	Height (inches)	3.87	3.87	4.15
	Moisture Content (%)	49.6	50.6	50.3
	Dry Density (PCF)	71.1	70.2	70.3
	Saturation (%)	100	100	100
	Void Ratio	1.28	1.31	1.30
Before Shear	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)			
	Void Ratio			
	Back Pressure (TSF)	0	0	0
Minor Principal Stress TSF (σ_3)		0.50	1.00	2.00
Maximum Deviator Stress TSF $(\sigma_1 - \sigma_3)$		0.56	0.55	0.66
Ultimate Deviator Stress TSF $(\sigma_1 - \sigma_3)$				
LL 77.5	PI 39.1	•	×	▲
PL 38.4	Gs 2.60			



TRIAXIAL TEST DATA

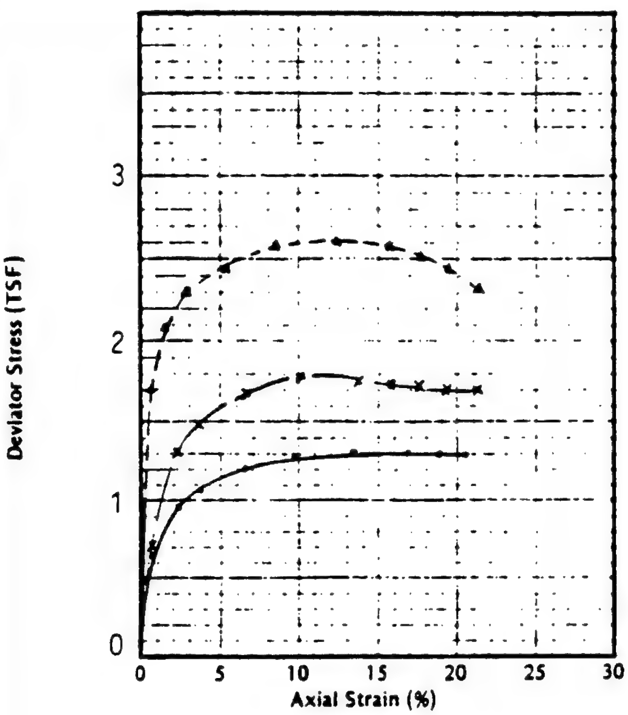
Date: April 1, 1988 Job No. 4220 88-226

Project: Chaska Creek Diversion

Boring No. 87-72M Sample No. 1 Depth (ft) 4-6 Type of Sample 5T

Soil Type: Organic Clay (OH) Type of Test: C-U W/Pore Pressure

Remarks: Specimens trimmed to given sizes; radial (spiral) drainage strips applied; saturated for 6 days under low confinement; backpressure and effective confining pressures increased in stages, to values shown; then maintained for 17-22 days; stressed under constant strain rates of 0.006"/min; Mohr circles at maximum stress ratio.



SPECIMEN NO.		1A	1B	1C	
Initial	Diameter (inches)	1.40	1.40	1.40	
	Height (inches)	2.90	2.88	2.86	
	Moisture Content (%)	56.4	55.5	54.5	
	Dry Density (PCF)	65.3	65.8	66.4	
	Saturation (%)	98.7	98.5	98.1	
	Void Ratio	1.48	1.47	1.44	
Before Shear	Moisture Content (%)	48.6	44.9	40.7	
	Dry Density (PCF)	71.8	74.9	78.3	
	Saturation (%)	100	100	100	
	Void Ratio	1.26	1.17	1.07	
	Back Pressure (TSF)	6.12	6.12	6.12	
Minor Principal Stress TSF (σ_3)		0.50	1.00	2.00	
Maximum Deviator Stress TSF ($\sigma_1 - \sigma_3$)		1.24	1.77	2.61	
Ultimate Deviator Stress TSF ($\sigma_1 - \sigma_3$)		1.2	1.7	2.3	
LL 77.5	PI 39.1				
PL 38.5	G_s 2.60				
		•	×	▲	

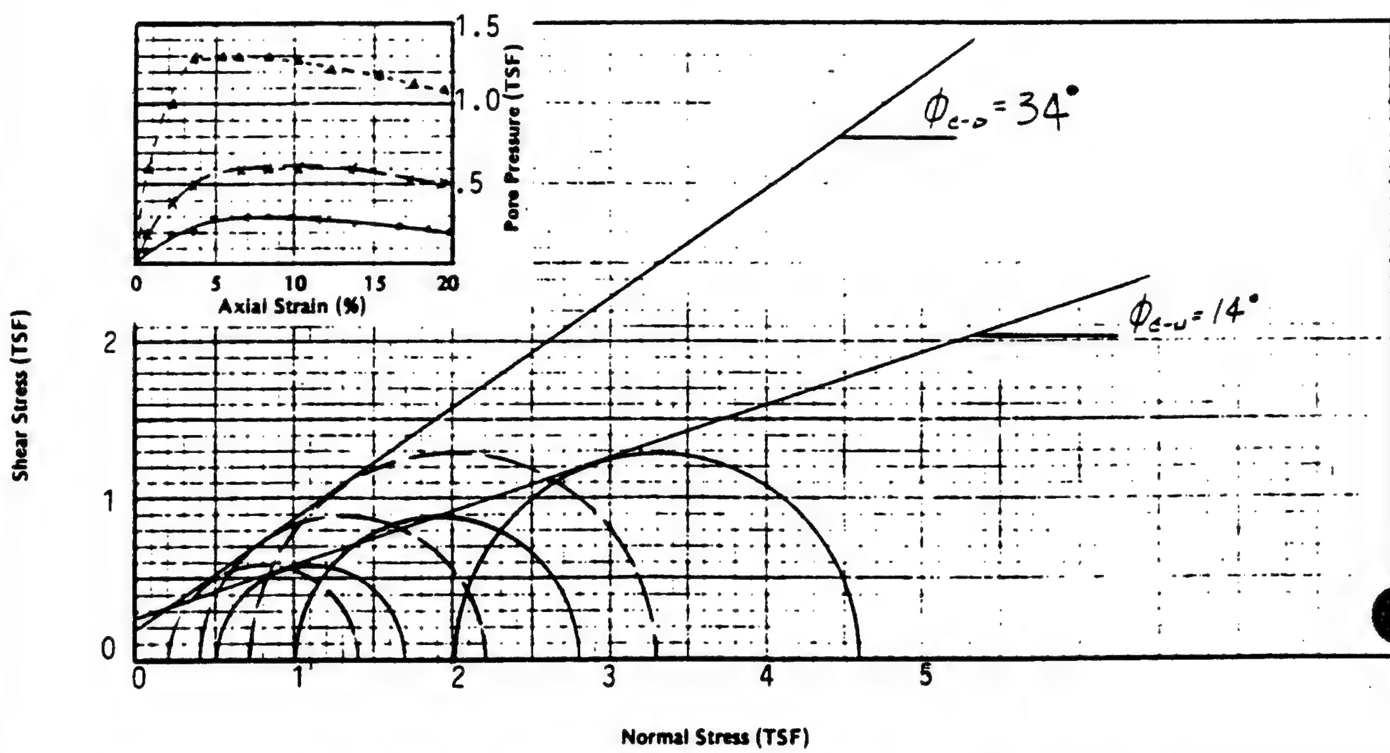


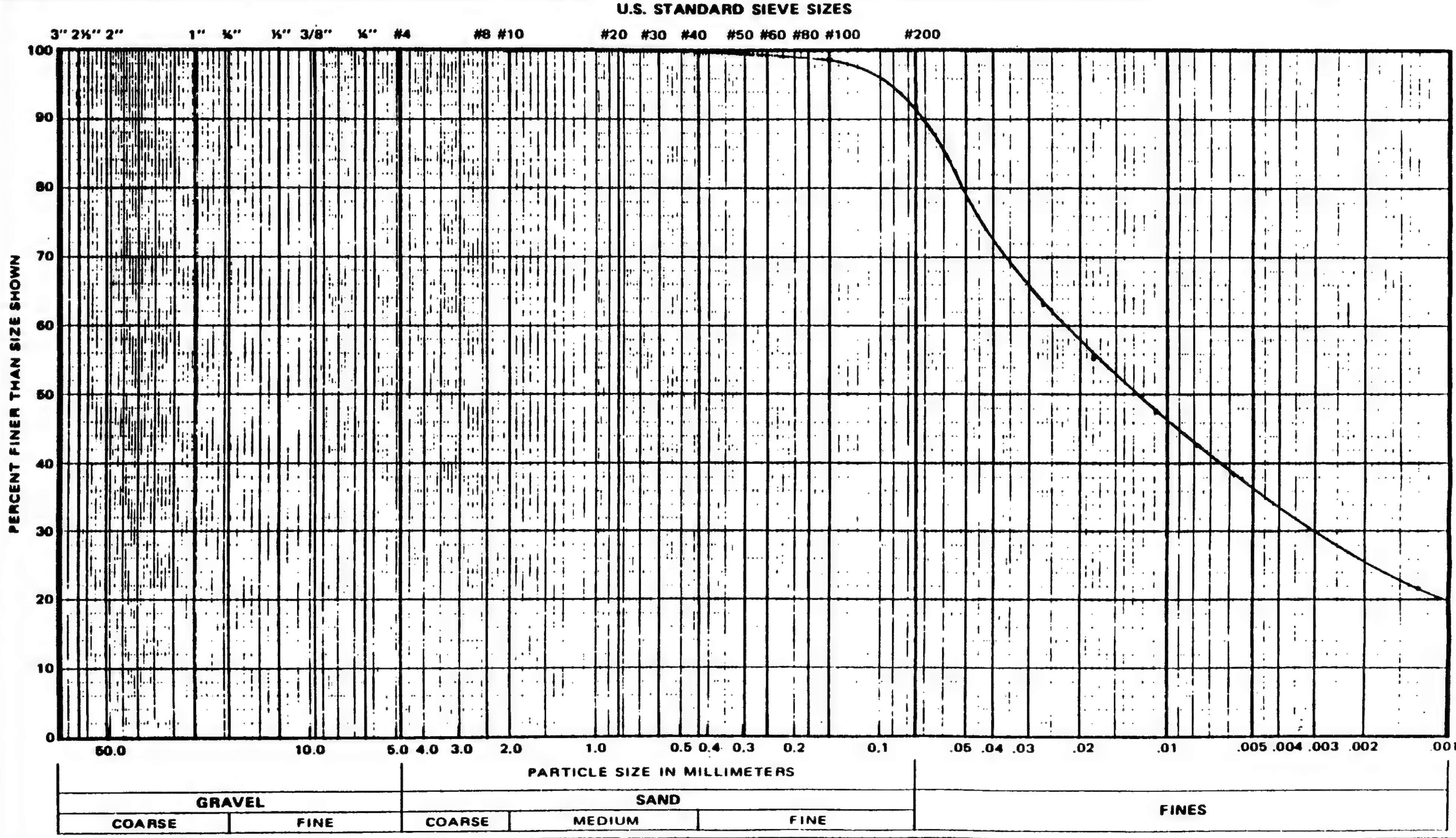
Figure C-16

GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE March 8, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-72M SAMPLE NO. 1 DEPTH (FT) 4-6 SOIL TYPE Organic Clay (OH)



662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

51-21 (77.8)

Figure C-163

TRIAXIAL TEST DATA

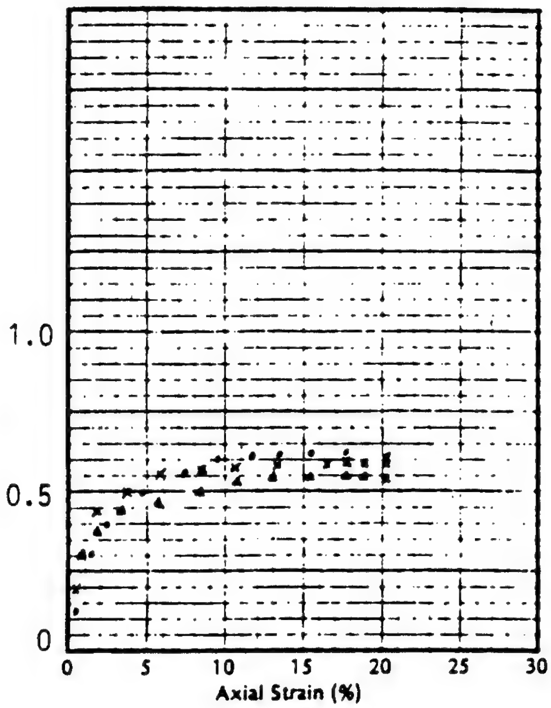
Date: March 3, 1988 Job No. 4220 88-226

Project: Chaska Creek Diversion

Boring No. 87-72M Sample No. 2 Depth (ft) 10-12 Type of Sample 5T

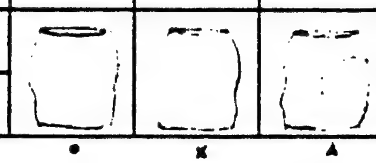
Soil Type: Fat Clay (CH) Type of Test: U-U

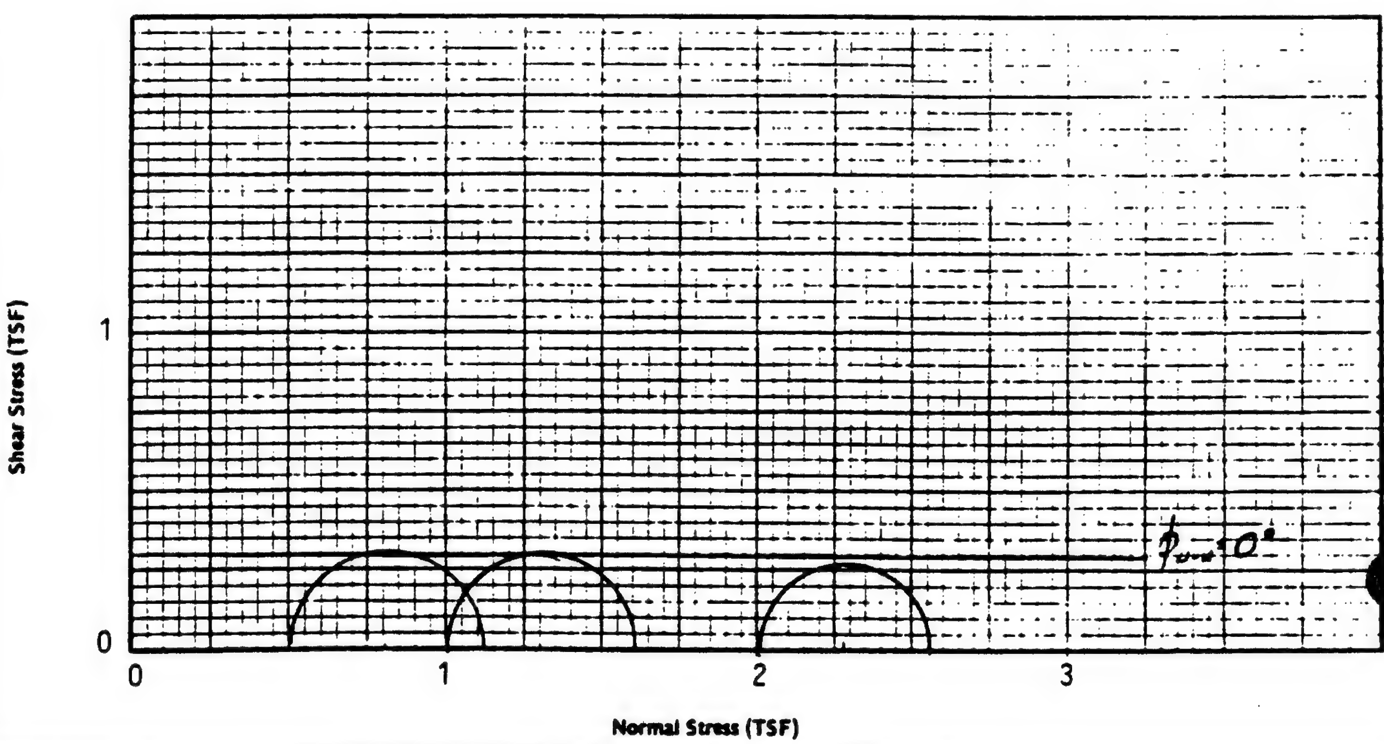
Remarks: Specimens trimmed to given sizes; lucite discs placed on each end; all drainage valves closed: stressed to given strains at constant rate of 0.060"/min.; Mohr circles at maximum deviator stress.



SPECIMEN NO.		A	B	C
Initial	Diameter (inches)	1.99	1.99	2.00
	Height (inches)	4.22	4.22	4.23
	Moisture Content (%)	44.8	39.2	42.2
	Dry Density (PCF)	77.4	80.2	77.1
	Saturation (%)	100	95.4	95.7
	Void Ratio	1.19	1.12	1.20
Before Shear	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)			
	Void Ratio			
	Back Pressure (TSF)	0	0	0
Minor Principal Stress TSF (σ_3)		0.50	1.00	2.00
Maximum Deviator Stress TSF ($\sigma_1 - \sigma_3$)		0.62	0.60	0.55
Ultimate Deviator Stress TSF ($\sigma_1 - \sigma_3$)				

LL 63.5	PI 42.1
PL 21.4	G_s 2.72





TRIAXIAL TEST DATA

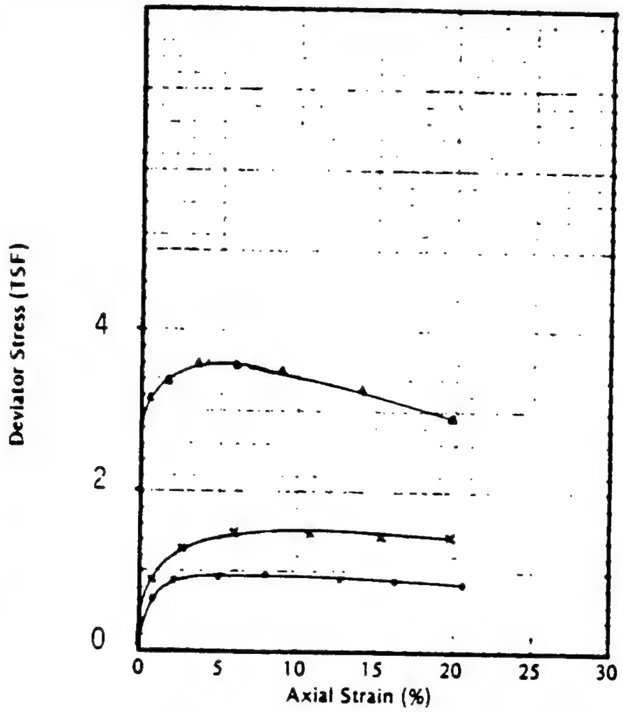
Date June 13, 1988 Job No. 4220 88-226

Project Chaska Creek Division

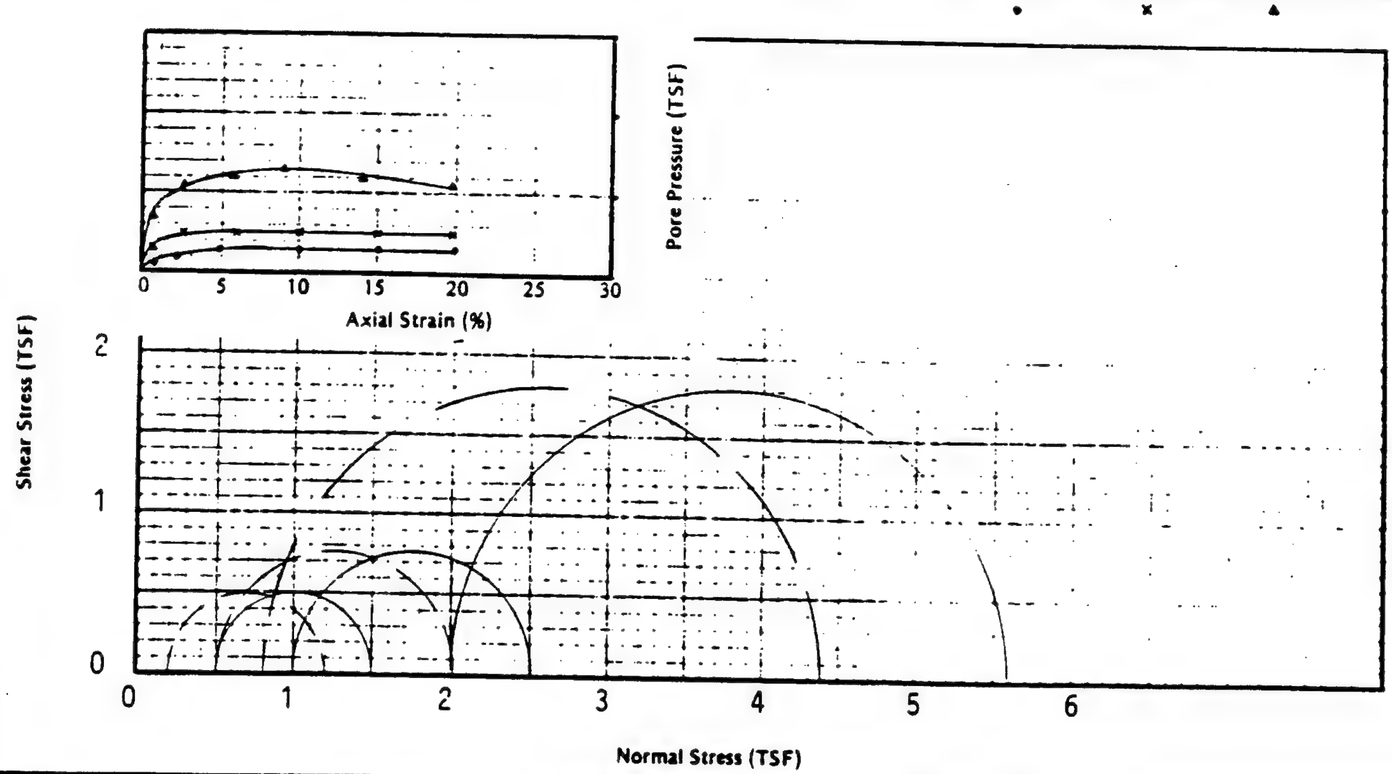
Boring No. 87-72m Sample No. 2 Depth (ft) 10-12 Type of Sample 5" Core

Soil Type Fat Clay (CH) Type of Test C-U w/pp

Remarks: Specimens trimmed to given sizes; radial (spiral) drainage strips applied; saturated for 18-28 days under low confinement; back pressure and effective confining pressures increased in stages, to values shown; then maintained for 14-15 days; stressed under constant strain rates of 0.006"/min; mohr circles at maximum stress ratio.

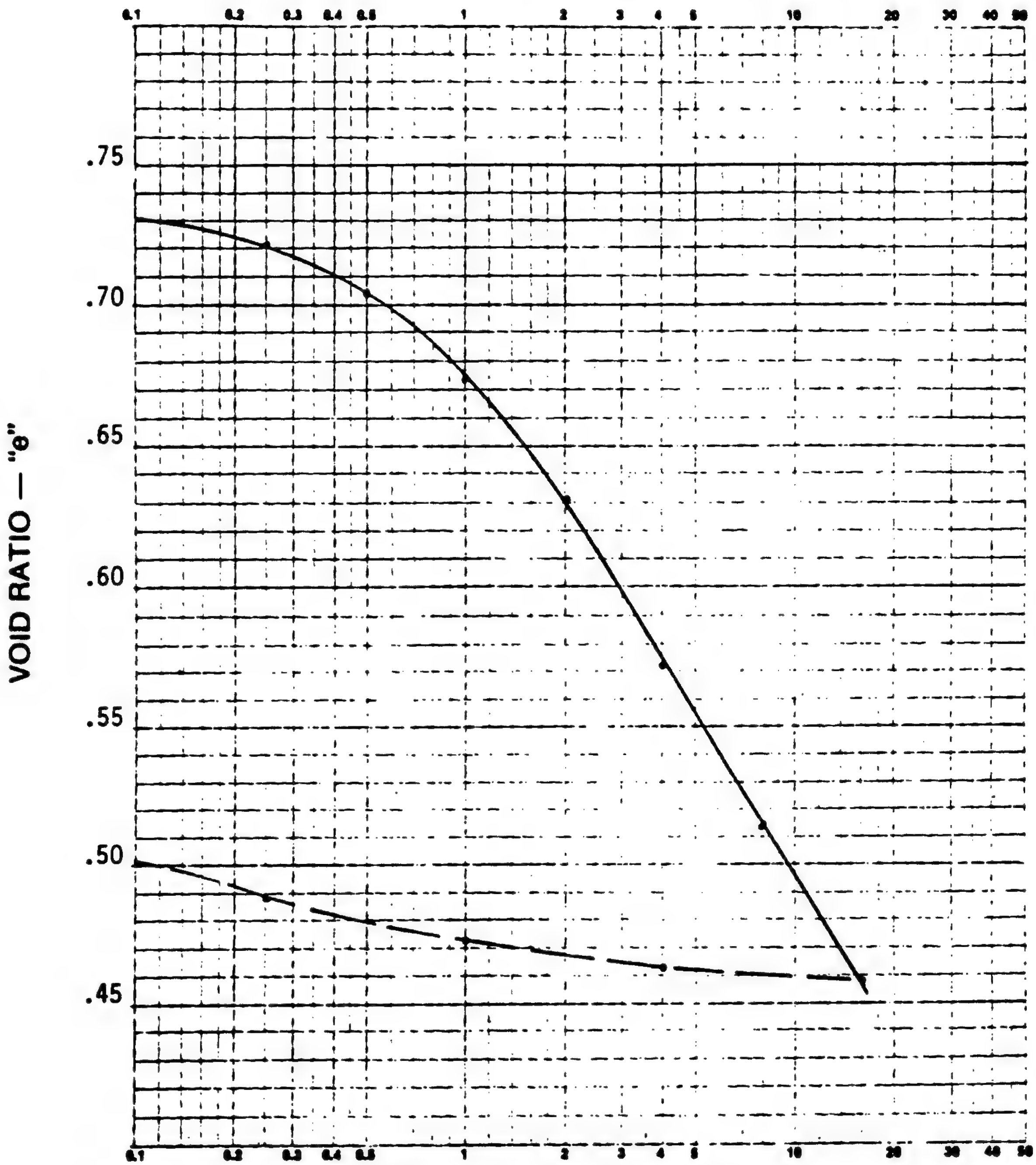


SPECIMEN NO.		A	B	C
Initial	Diameter (inches)	1.41	1.41	1.42
	Height (inches)	2.94	3.04	3.08
	Moisture Content (%)	28.3	28.3	20.8
	Dry Density (PCF)	86.4	89.3	94.0
	Saturation (%)	79.9	85.5	70.1
	Void Ratio	.96	.90	.81
Before Shear	Moisture Content (%)	34.5	31.2	26.7
	Dry Density (PCF)	87.5	91.7	98.2
	Saturation (%)	99.8	99.6	99.7
	Void Ratio	.94	.85	.73
	Back Pressure (TSF)	6.12	6.12	6.12
Minor Principal Stress TSF (σ_3)		0.50	1.00	2.00
Maximum Deviator Stress TSF ($\sigma_1 - \sigma_3$)		0.98	1.51	3.60
Ultimate Deviator Stress TSF ($\sigma_1 - \sigma_3$)		0.8	1.4	2.9
LL 63.5	PI 42.1			
PL 21.4	G_s 2.72	•	×	▲



CONSOLIDATION TEST CURVE

VOID RATIO VS. PRESSURE



Project CHASKA CREEK DIVERSION

Job No. 87-72M GS = 2.72 Date May 2, 1988

Boring No. 87-72M Soil Type (ASTM: D2487) Fat clay (CH)

Sample No. 2 Original Moisture Content, Dry Density 27.7 % 96.4 PCF

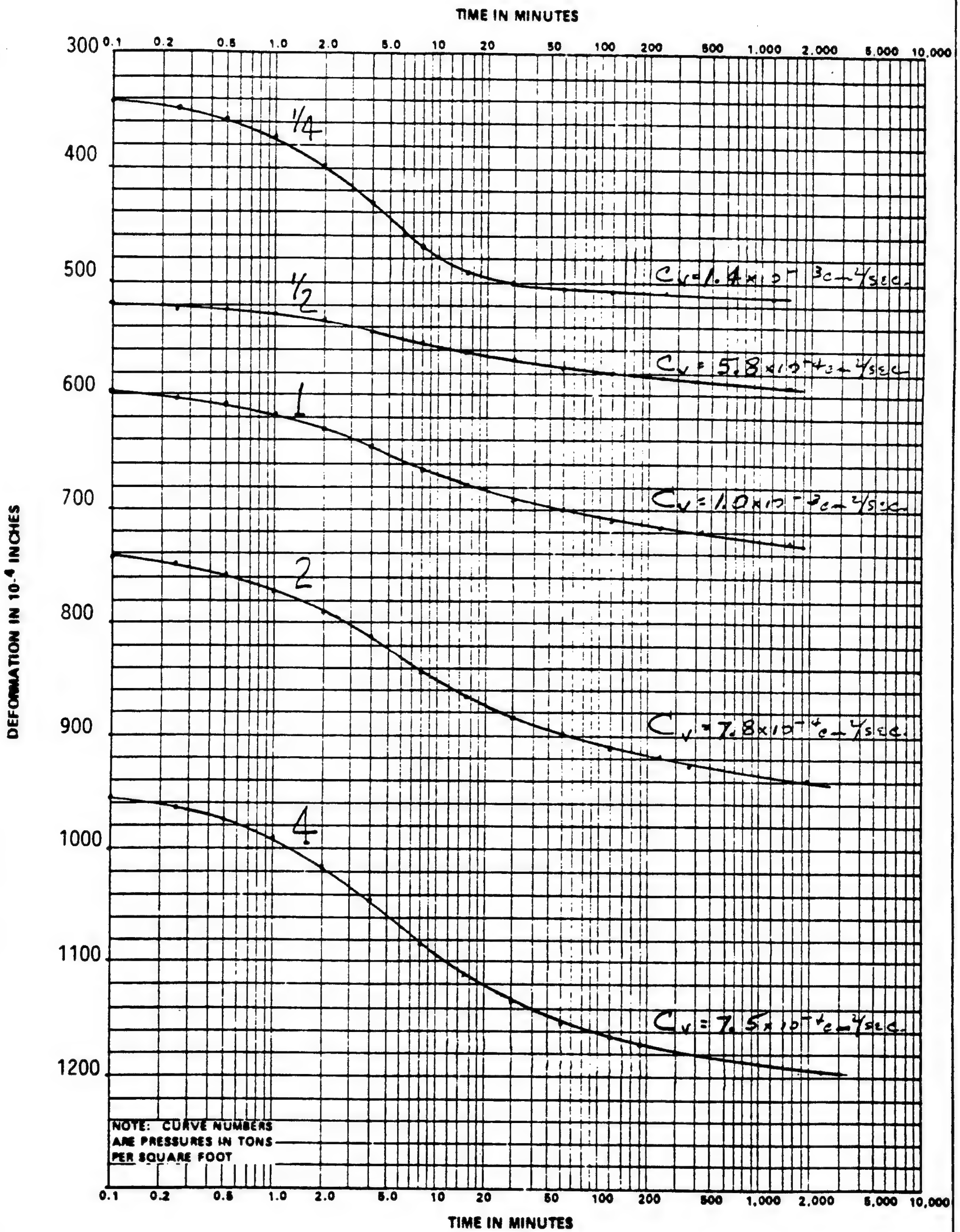
Depth (FT.) 10-12 Liquid Limit 63.5 % Plastic Limit 21.4 %

Initial Sample Height (IN.) 0.795 Preconsolidation Pressure (Pc) 0.9 TSF

Sample Diameter (IN.) 2.501 Compression & Recompression Index: C_c 0.19 C_r 0.04

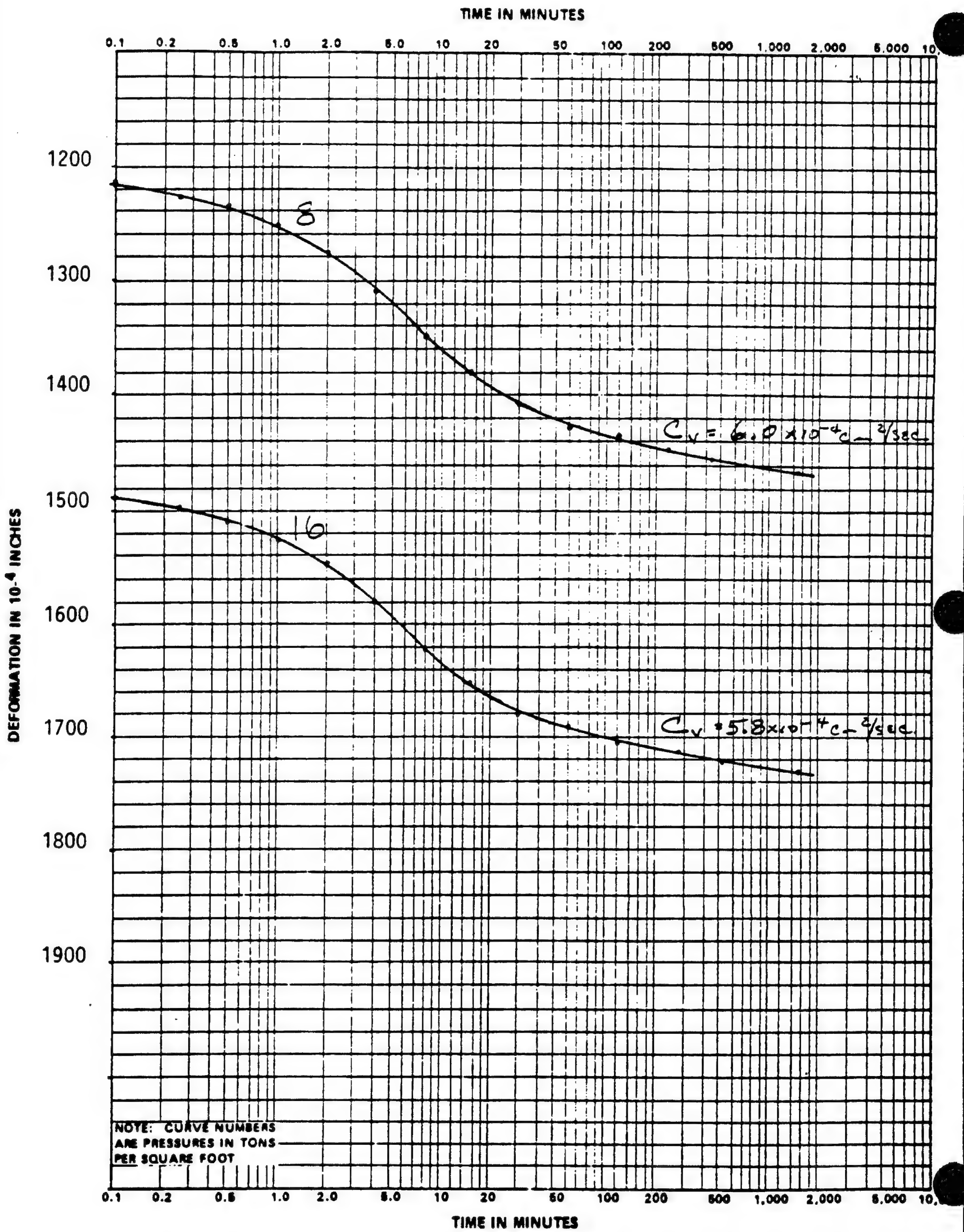
662 CROMWELL AVENUE ST PAUL MN 55114

CONSOLIDATION TEST TIME CURVES



PROJECT:	CHASKA CREEK DIVERSION						
JOB NO.:	4220 88-226	SAMPLE NO.:	2	BORING NO.:	87-72M	DEPTH:	10'-12'

CONSOLIDATION TEST TIME CURVES



PROJECT: CHASKA CREEK DIVERSION			
JOB NO.: 4220 88-226	SAMPLE NO.: 2	BORING NO.: 87-72M	DEPTH: 10'-12'

SL-17 (77-8) 662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

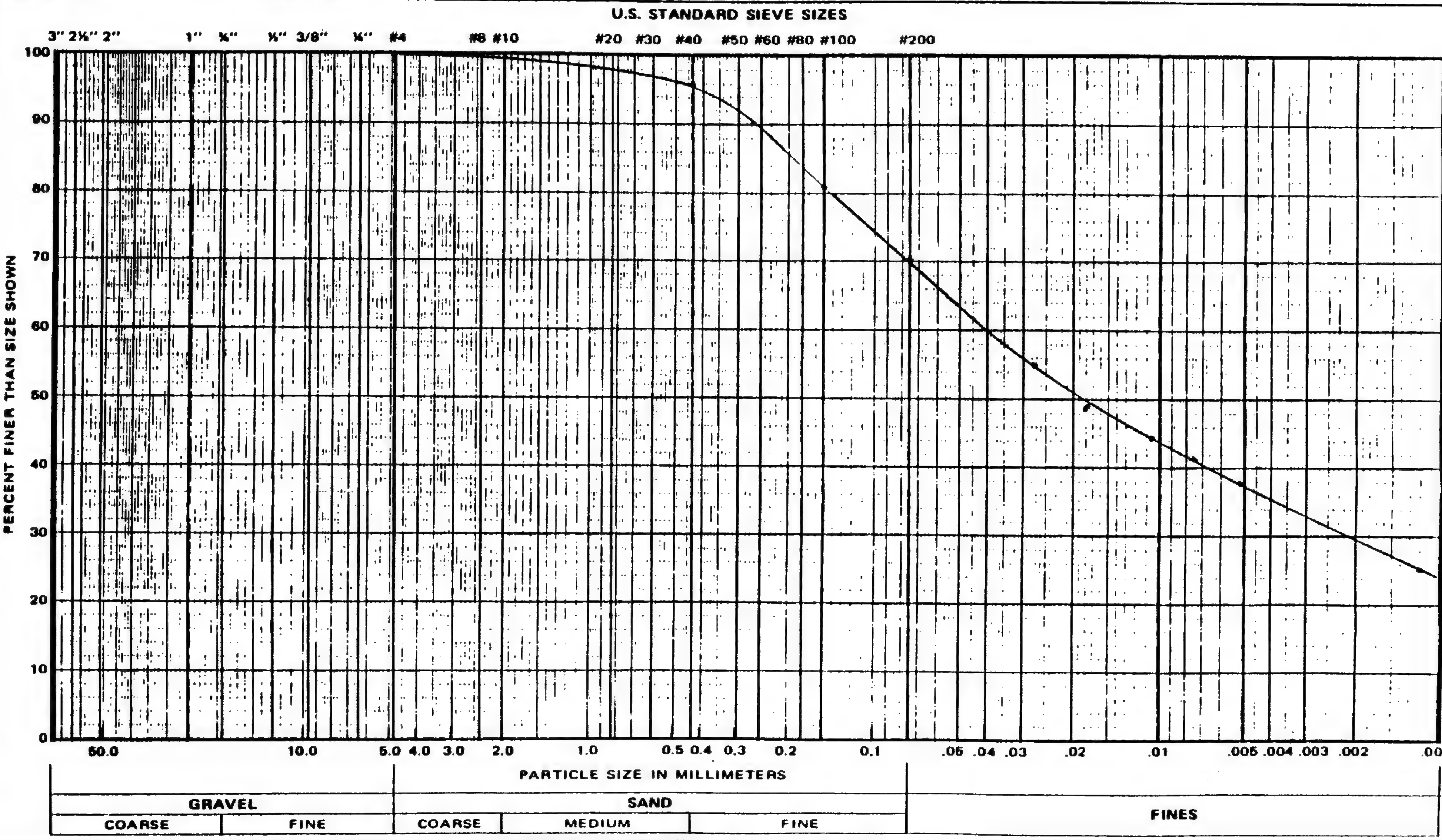
Figure C-1

GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion **DATE** March 8, 1988

REPORTED TO St. Paul District Corps of Engineers **JOB NO.** #4220 88-226

BORING NO. 87-72M **SAMPLE NO.** 2 **DEPTH (FT)** 10-12 **SOIL TYPE** Fat Clay W/Sand (CH)



662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

SL-21 (77-B)

Figure C-169

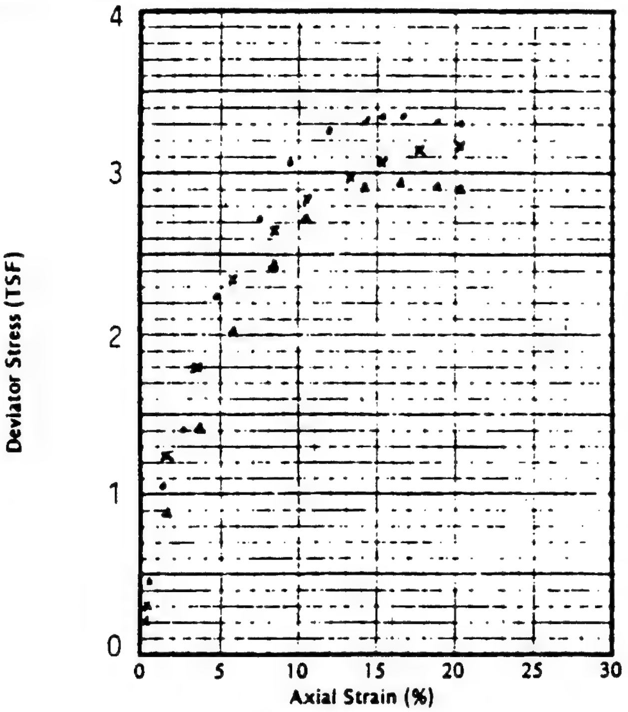
TRIAXIAL TEST DATA Date March 3, 1988 Job No. 4220 88-226

Project Chaska Creek Diversion

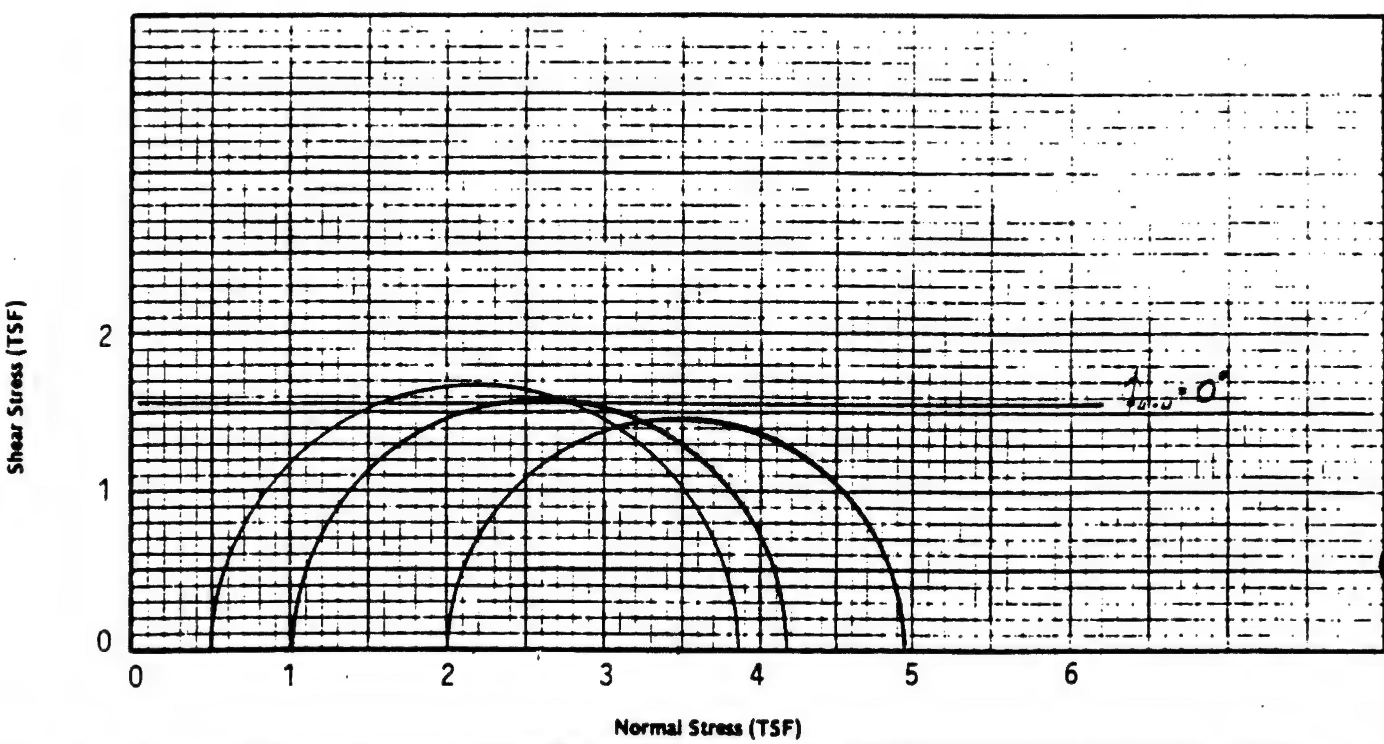
Boring No. 87-72M Sample No. 3 Depth (ft) 21-23 Type of Sample 5T

Soil Type Silty Clay (CL-ML/CL) Type of Test U-U

Remarks: Specimens trimmed to given sizes; lucite discs placed on each end; all drainage valves closed; stressed to given strains at constant rate of 0.060"/min.; Mohr circles at maximum deviator stress.



SPECIMEN NO.		A	B	C
Initial	Diameter (inches)	2.00	2.00	2.00
	Height (inches)	4.23	4.22	4.22
	Moisture Content (%)	23.4	23.7	23.5
	Dry Density (PCF)	103.4	103.1	103.3
	Saturation (%)	100	100	100
	Void Ratio	0.61	0.61	0.61
Before Shear	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)			
	Void Ratio			
	Back Pressure (TSF)	0	0	0
Minor Principal Stress TSF (σ_3)		0.50	1.00	2.00
Maximum Deviator Stress TSF ($\sigma_1 - \sigma_3$)		3.34	3.18	2.94
Ultimate Deviator Stress TSF ($\sigma_1 - \sigma_3$)				
LL 28.1	PI 7.7			
PL 20.4	G_s 2.67	•	x	▲



TRIAXIAL TEST DATA

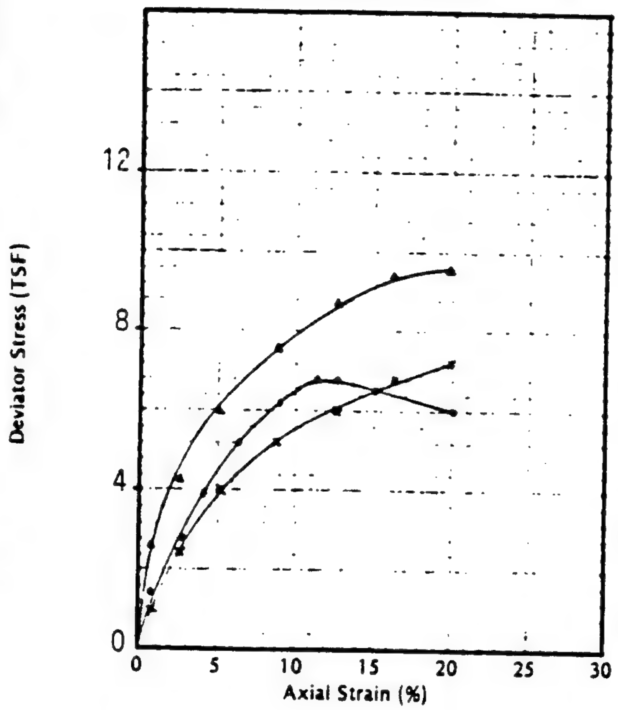
Date June 1988 Job No. 4220 88-226

Project Chaska Creek Division

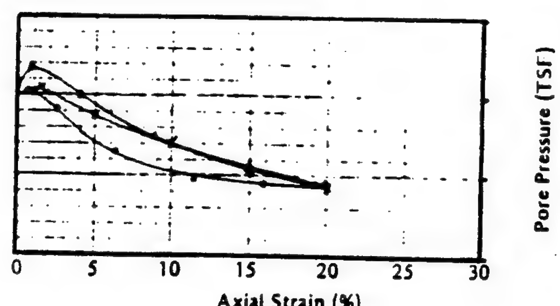
Boring No. 87-72m Sample No. 3 Depth (ft) 21-23 Type of Sample 5" Core

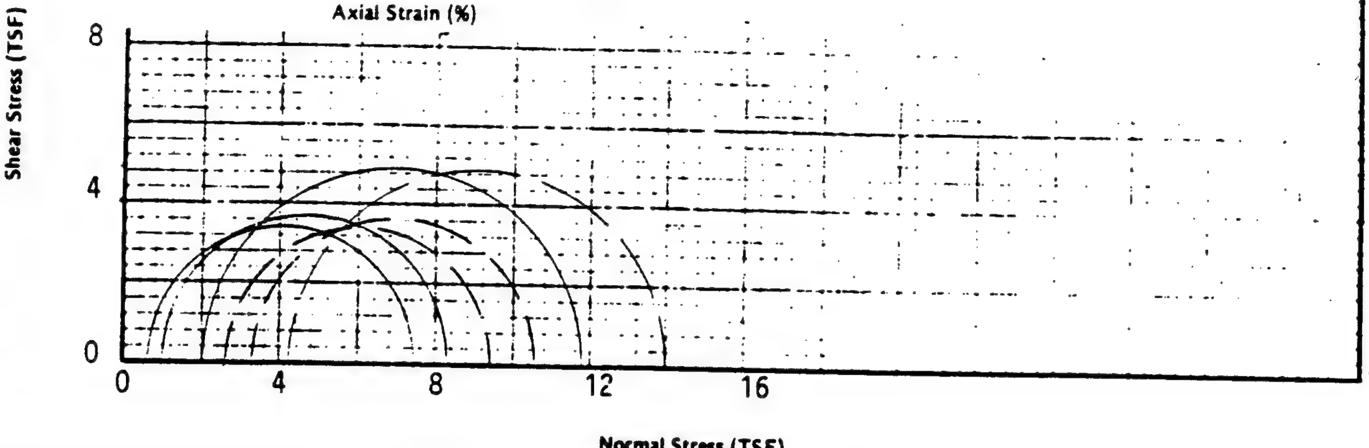
Soil Type Silty Clay (CL-ML) Type of Test C-U w/pp

Remarks: Specimens trimmed to given sizes; radial (spiral) drainage strips applied; saturated for 20-26 days under low confinement; back pressure and effective confining pressures increased in stages, to values shown; then maintained for 17-19 days; stressed under constant strain rates of 0.006"/min; mohr circles at maximum stress ratio.



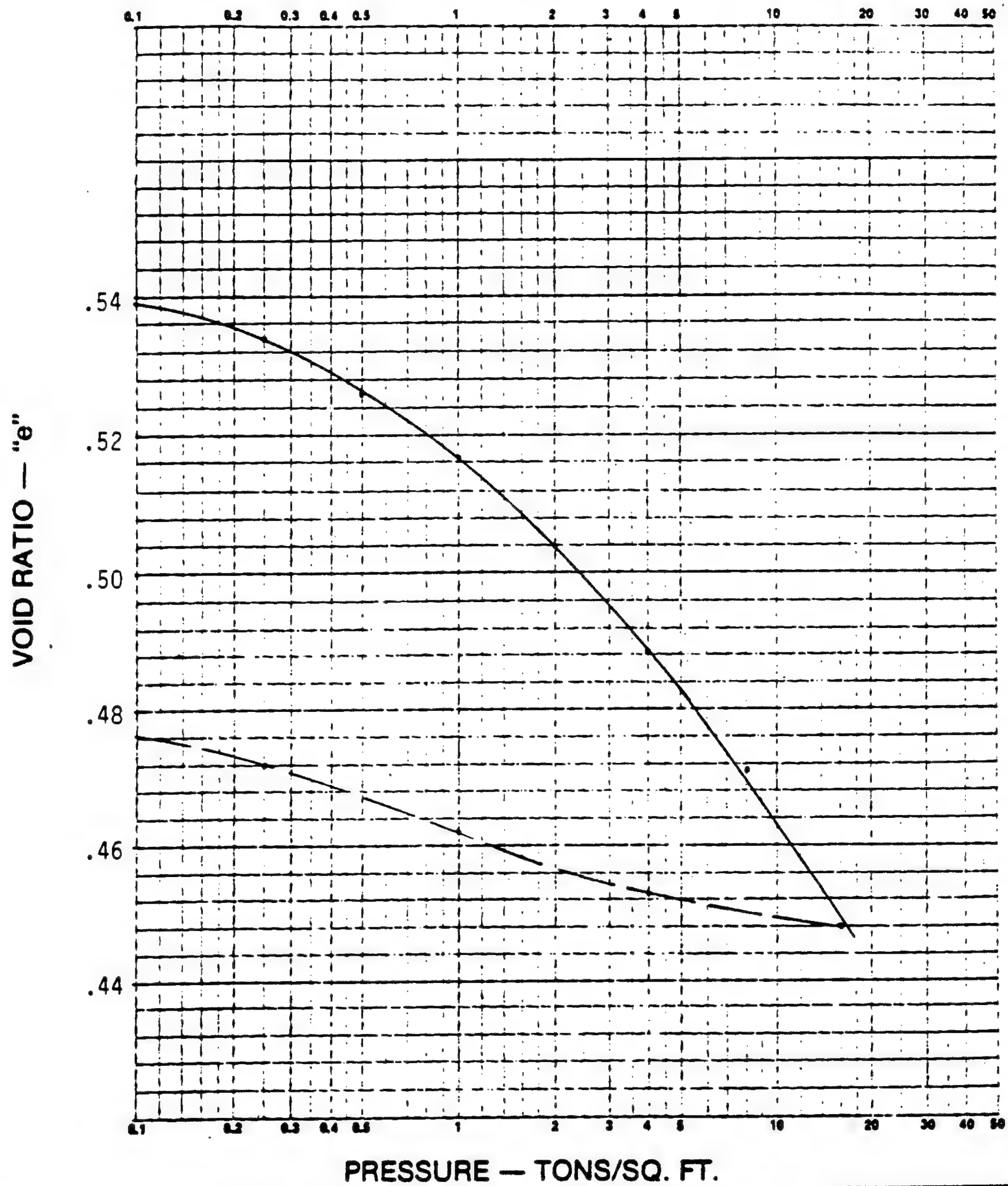
SPECIMEN NO.		A	B	C
Initial	Diameter (inches)	2.00	2.00	2.00
	Height (inches)	4.01	4.01	4.00
	Moisture Content (%)	20.9	21.4	21.6
	Dry Density (PCF)	106.2	105.3	105.0
	Saturation (%)	98.1	97.7	98.2
	Void Ratio	.57	.58	.58
Before Shear	Moisture Content (%)	21.3	21.5	21.2
	Dry Density (PCF)	106.3	106.0	106.5
	Saturation (%)	98.9	100.0	99.8
	Void Ratio	.57	.57	.57
	Back Pressure (TSF)	6.12	6.12	6.12
Minor Principal Stress TSF $(\bar{\sigma}_3)$		0.50	1.00	2.00
Maximum Deviator Stress TSF $(\bar{\sigma}_1 - \bar{\sigma}_3)$		6.77	7.18	9.58
Ultimate Deviator Stress TSF $(\bar{\sigma}_1 - \bar{\sigma}_3)$		6.0	7.2	9.6
LL 28.1	PI 7.7			
PL 20.4	G_s 2.67			





CONSOLIDATION TEST CURVE

VOID RATIO VS. PRESSURE



Project Chaska Creek Diversion

Job No. 4220 88-226

G_S =2.67

Date March 1, 1988

Boring No. 87-72M

Soil Type (ASTM: D2487) Silty Clay (CL-ML/CL)

Sample No. 3

Original Moisture Content, Dry Density 21.8 % 107.9 PCF

Depth (FT.) 21-23 (Top)

Liquid Limit 28.1 % Plastic Limit 20.4 %

Initial Sample Height (IN.) 0.799

Preconsolidation Pressure (Pc) 1.6 tsf

Sample Diameter (IN.) 2.501

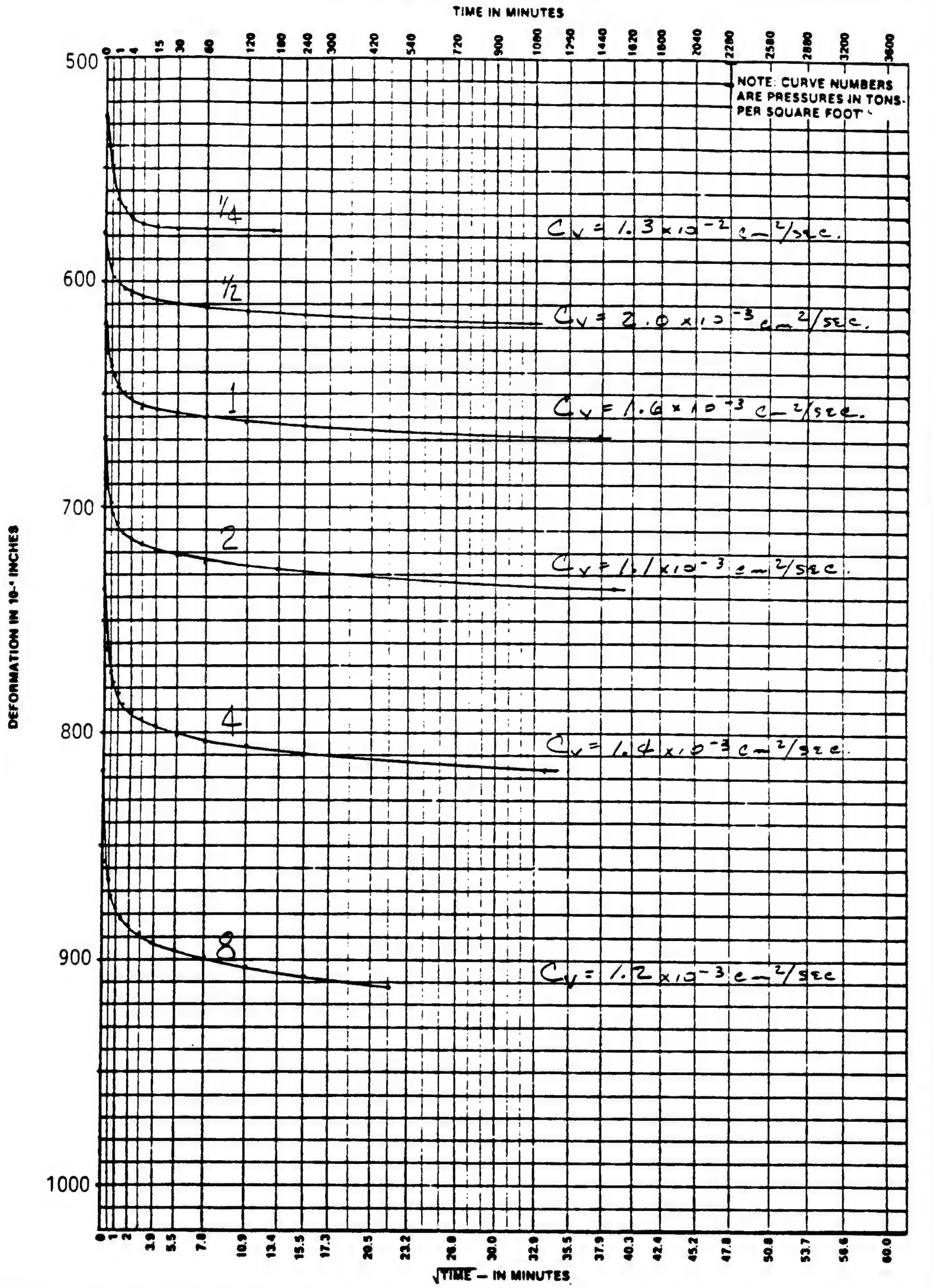
Compression & Recompression Index: C_c 0.07 C_r

662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

SL-6 (77-C)

Figure C-172

CONSOLIDATION TEST TIME CURVES



PROJECT Chaska Creek Diversion

JOB. NO. 4220 88-226 | SAMPLE NO. 3 | BORING NO. 87-72M | DEPTH 21'-23' (Top)

862 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

SL-38 (77-8)

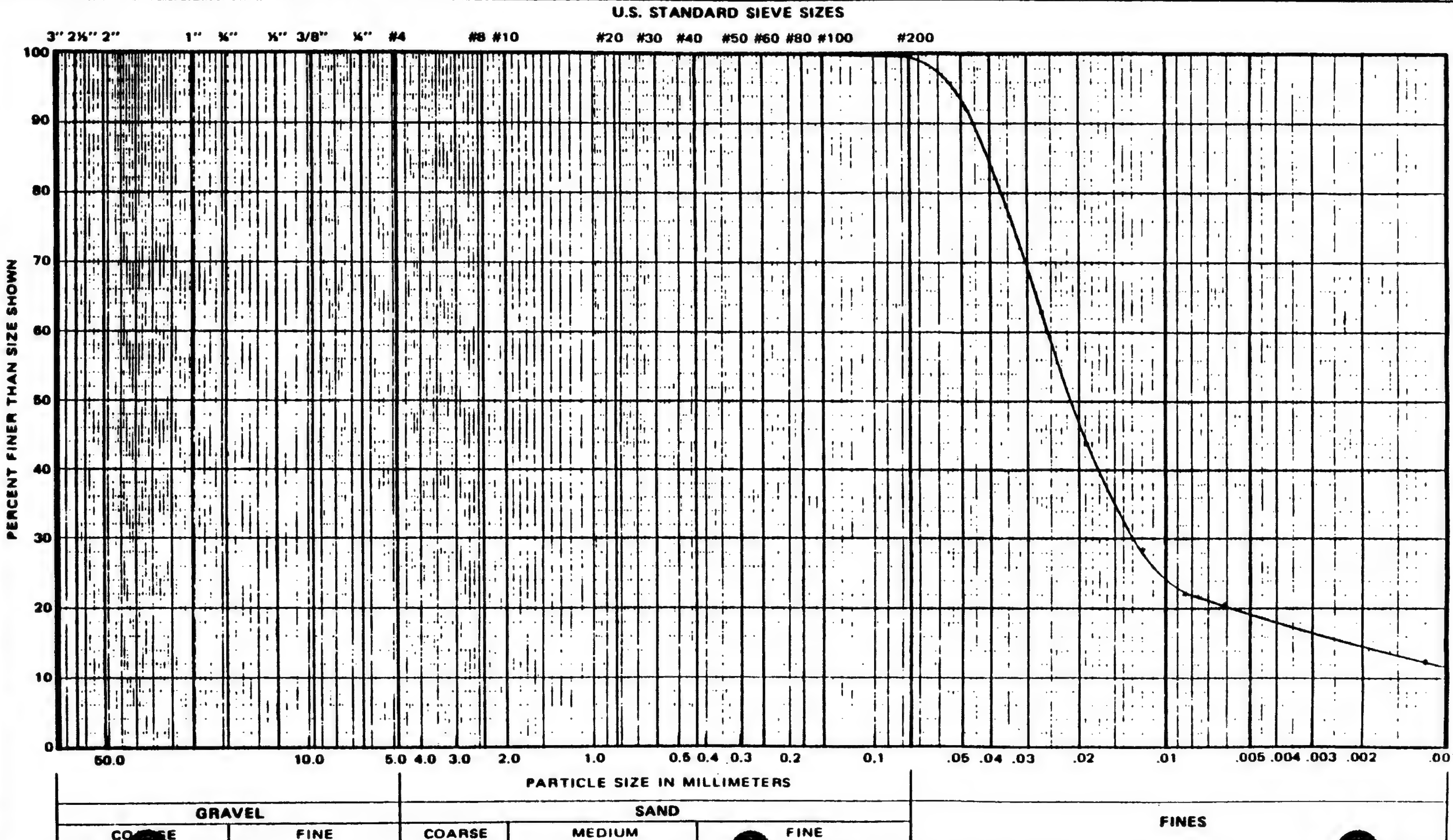
Figure C-173

GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE March 8, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-72M SAMPLE NO. 3 DEPTH (FT) 21-23 SOIL TYPE Silty Clay (CL-ML/CL)



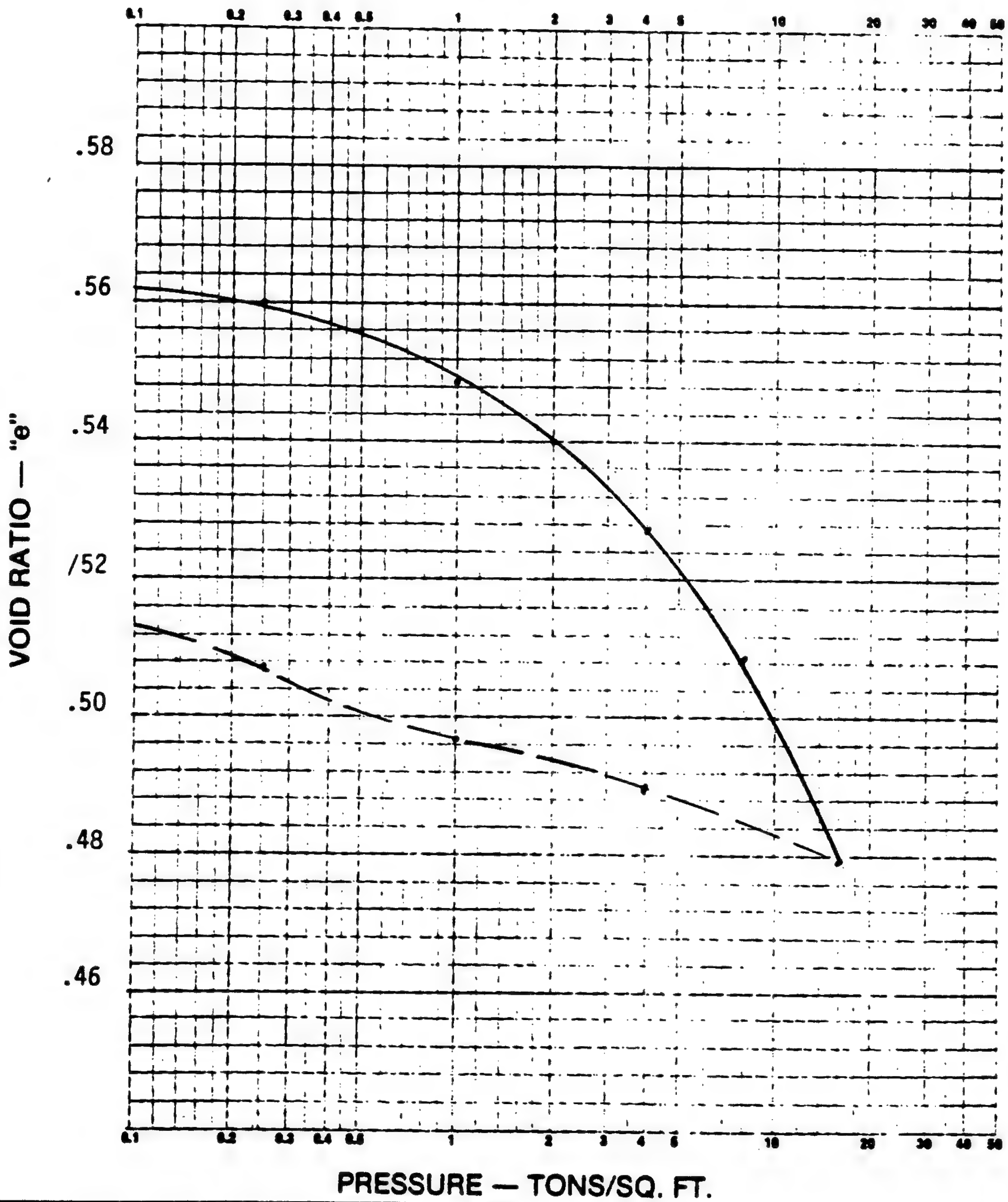
662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

SL-21 (77-8)

Figure C-174

CONSOLIDATION TEST CURVE

VOID RATIO VS. PRESSURE



Project CHASKA CREEK DIVERSION

Job No. 4220 88-226 | GS = 2.68 | Date May 18, 1988

Boring No. 87-72M | Soil Type (ASTM: D2487) Lean clay (CL)

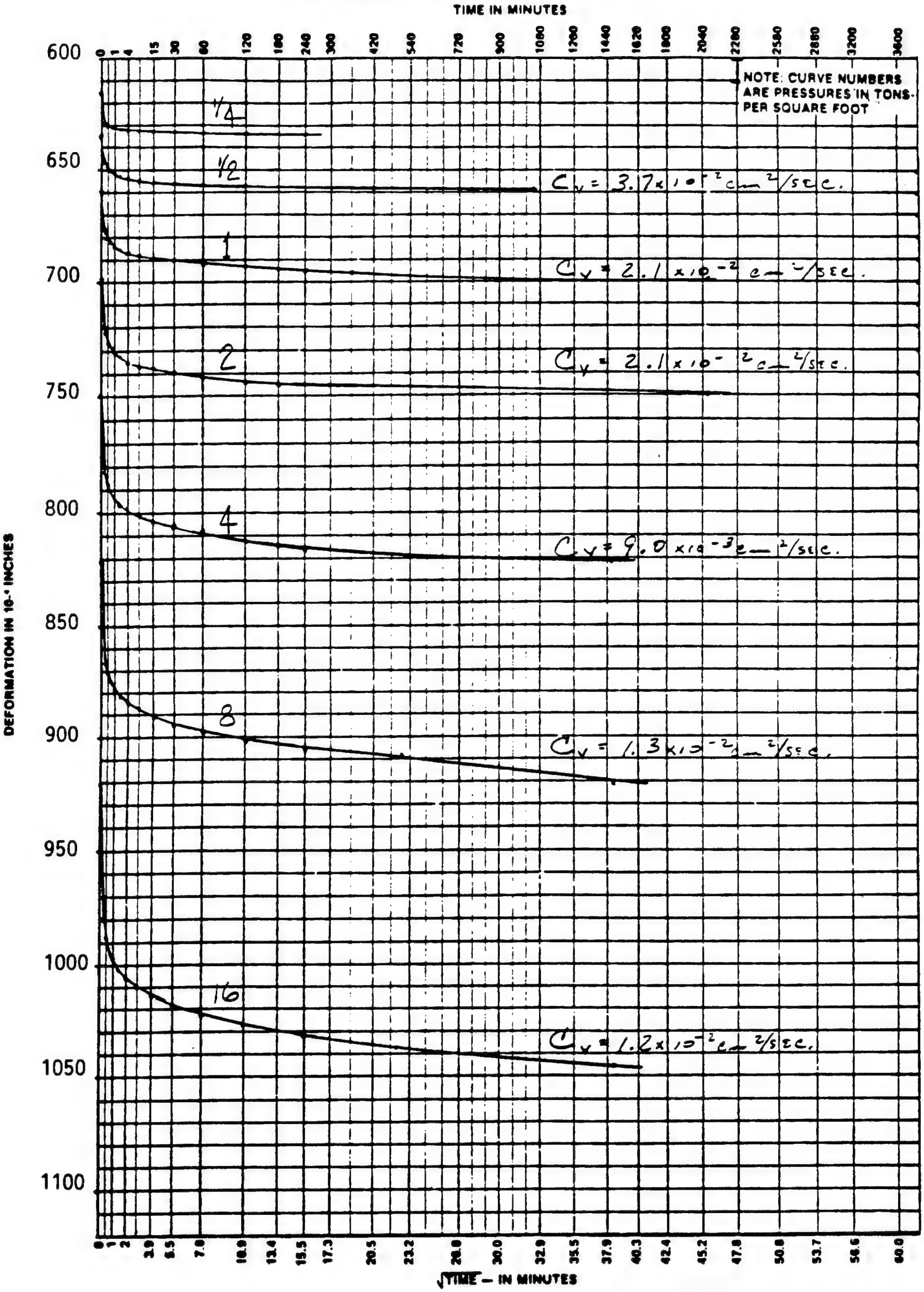
Sample No. 4 | Original Moisture Content, Dry Density 21.3 % 107.0 PCF

Depth (FT.) 28.0-29.4 | Liquid Limit 30.0 % Plastic Limit 16.5 %

Initial Sample Height (IN.) 0.797 | Preconsolidation Pressure (Pc) 2.7 tsf

Sample Diameter (IN.) 2.501 | Compression & Recompression Index: C_c 0.07 C_r 0.01

CONSOLIDATION TEST TIME CURVES



PROJECT	CHASKA CREEK DIVERSION		
JOB NO. 4220 88-226	SAMPLE NO. 4	BORING NO. 87-72M	DEPTH 28.0'-29.4'

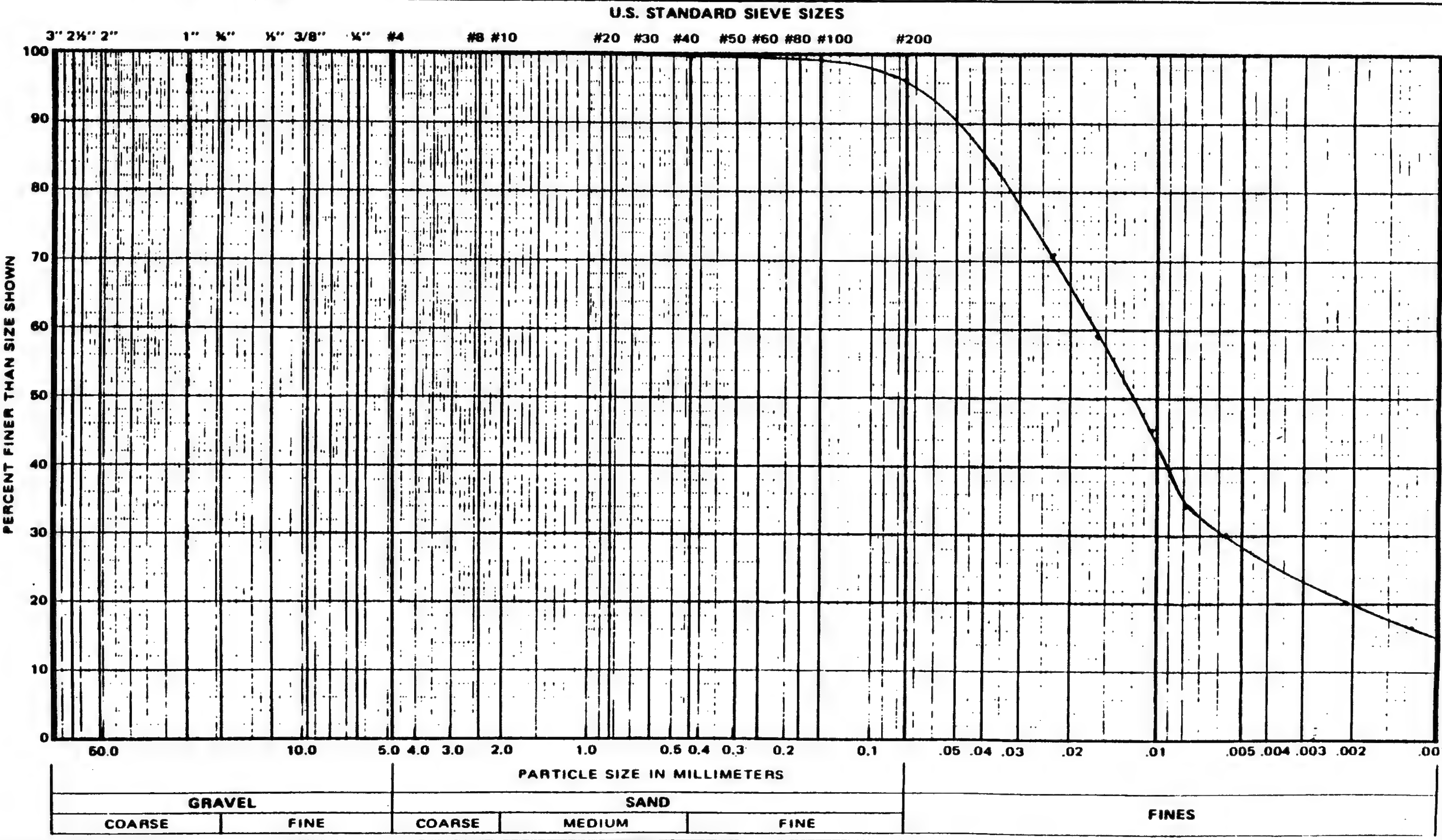
662 CROMWELL AVENUE twin city testing ST. PAUL, MN. 55114

GRAIN SIZE DISTRIBUTION CURVE

PROJECT CHASKA CREEK DIVERSION DATE May 18, 1988

REPORTED TO ST PAUL DISTRICT CORPS OF ENGINEERS JOB NO. 4220 88-226

BORING NO. 87-72M SAMPLE NO. 4 DEPTH (FT) 28.0-29.4 SOIL TYPE Lean clay (CL)



TRIAXIAL TEST DATA

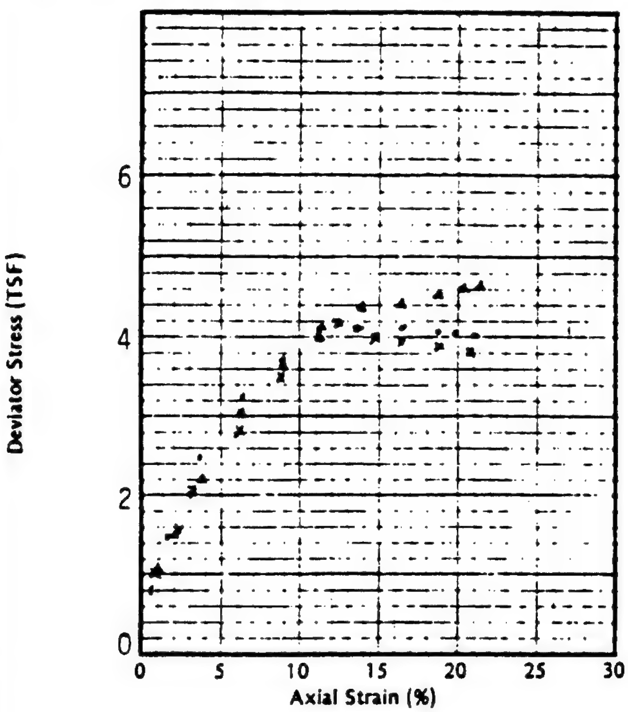
Date March 3, 1988 Job No. 4220 88-226

Project Chaska Creek Diversion

Boring No. 87-72M Sample No. 5 Depth (ft) 35-37 Type of Sample ST

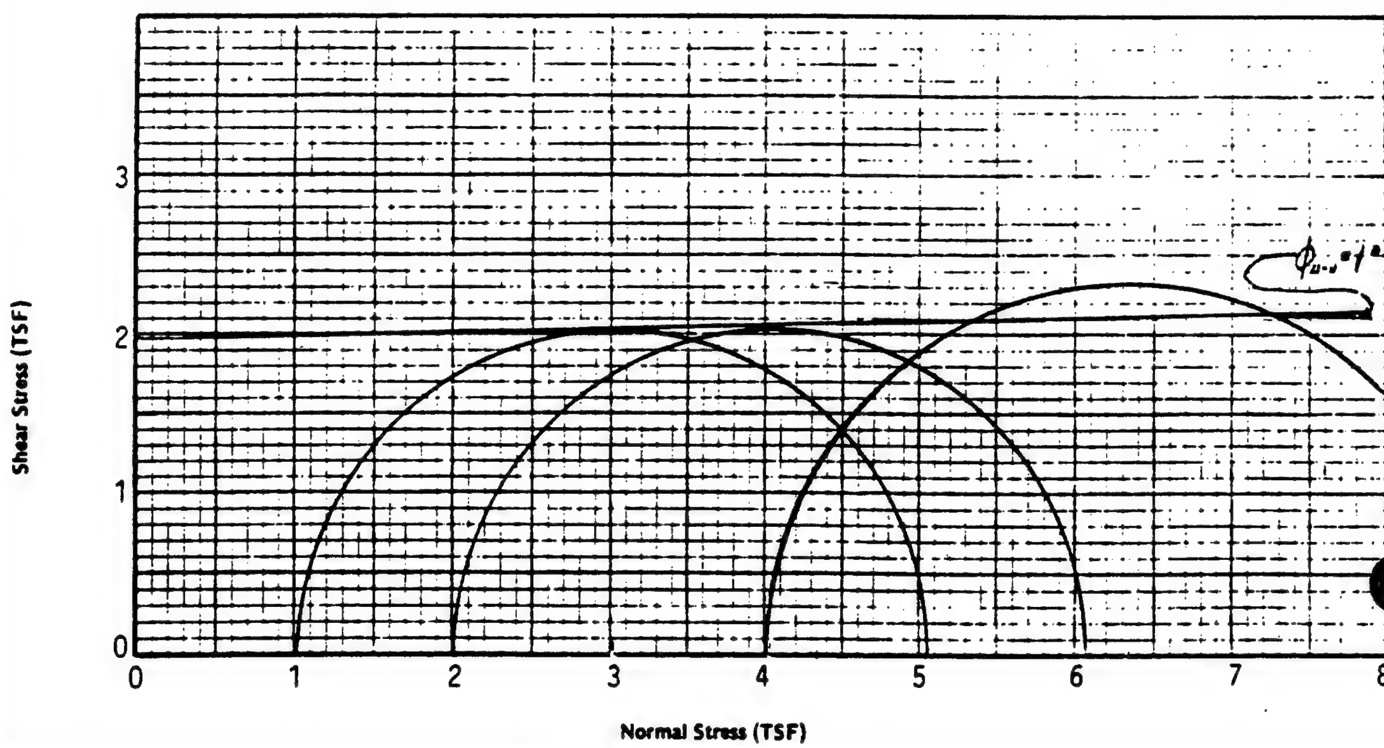
Soil Type Lean Clay (CL) Type of Test U-U

Remarks: Specimens trimmed to given sizes; lucite discs placed on each end; all drainage valves closed; stressed to given strains at constant rate of 0.060"/min.; Mohr circles at maximum deviator stress.



	SPECIMEN NO.	A	B	C
Initial	Diameter (inches)	1.99	1.99	1.99
	Height (inches)	4.03	4.05	3.99
	Moisture Content (%)	22.0	22.5	22.8
	Dry Density (PCF)	104.2	105.7	104.0
	Saturation (%)	96.5	100	99.6
	Void Ratio	0.62	0.59	0.62
Before Shear	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)			
	Void Ratio			
	Back Pressure (TSF)	0	0	0
	Minor Principal Stress TSF (σ_3)	1.00	2.00	4.00
	Maximum Deviator Stress TSF ($\sigma_1 - \sigma_3$)	4.06	4.10	4.66
	Ultimate Deviator Stress TSF ($\sigma_1 - \sigma_3$)			

LL 37.4	PI 17.1
PL 20.3	G_s 2.70



TRIAXIAL TEST DATA

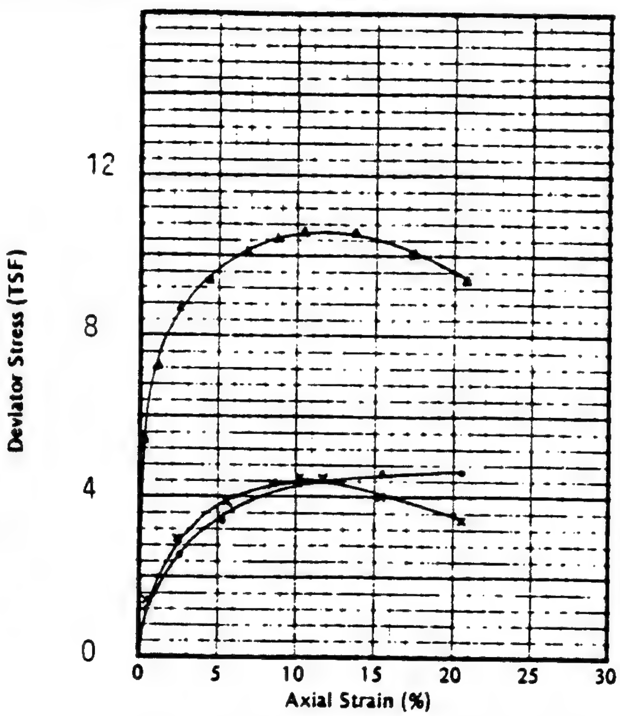
Date October 17, 1988 Job No. 4220 88-226

Project Chaska Creek Diversion

Boring No. 87-72m Sample No. 5 Depth (ft) 35-37 Type of Sample 5" Core

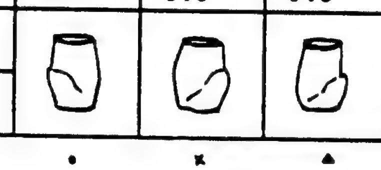
Soil Type Lean Clay (CL) Type of Test C-W w/pp

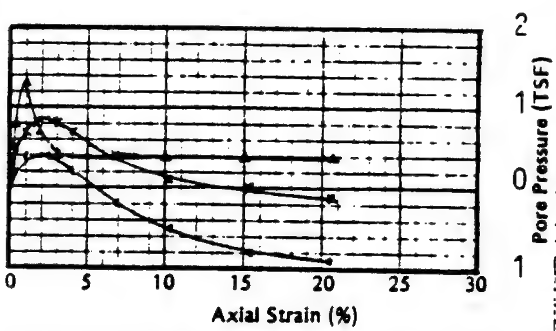
Remarks: Specimens trimmed to given sizes; radial (spiral) drainage strips applied; saturated for 26-36 days under low confinement; back pressure and effective confining pressures increased in stages, to values shown; then maintained for 17-22 days; stressed under constant strain rates of 0.006"/min; mohr circles at maximum stress ratio.

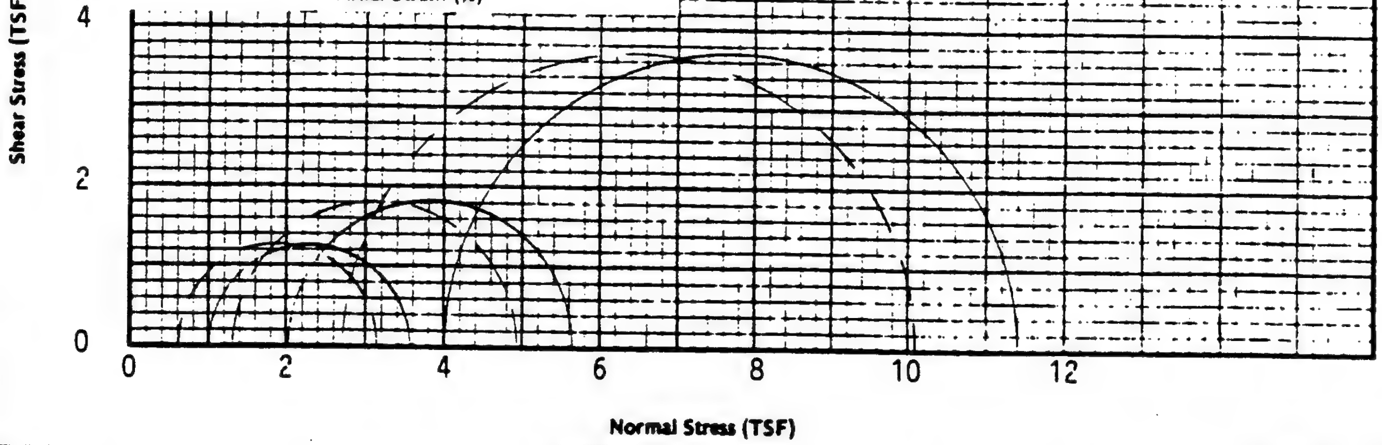


	SPECIMEN NO.	A	B	C
Initial	Diameter (inches)	1.41	1.41	1.41
	Height (Inches)	2.95	2.95	2.93
	Moisture Content (%)	20.2	13.6	14.8
	Dry Density (PCF)	106.6	102.2	100.8
	Saturation (%)	93.8	98.4	99.8
	Void Ratio	.58	.65	.67
Before Shear	Moisture Content (%)	20.8	22.4	22.2
	Dry Density (PCF)	107.8	104.9	105.3
	Saturation (%)	99.5	99.6	99.9
	Void Ratio	.56	.61	.60
	Back Pressure (TSF)	6.12	6.12	6.12
Minor Principal Stress TSF (σ_3)		1.00	2.00	4.00
Maximum Deviator Stress TSF ($\sigma_1 - \sigma_3$)		4.67	4.35	10.52
Ultimate Deviator Stress TSF ($\sigma_1 - \sigma_3$)		4.7	3.6	9.5

LL 37.4	PI 17.1
PL 20.3	G_s 2.70

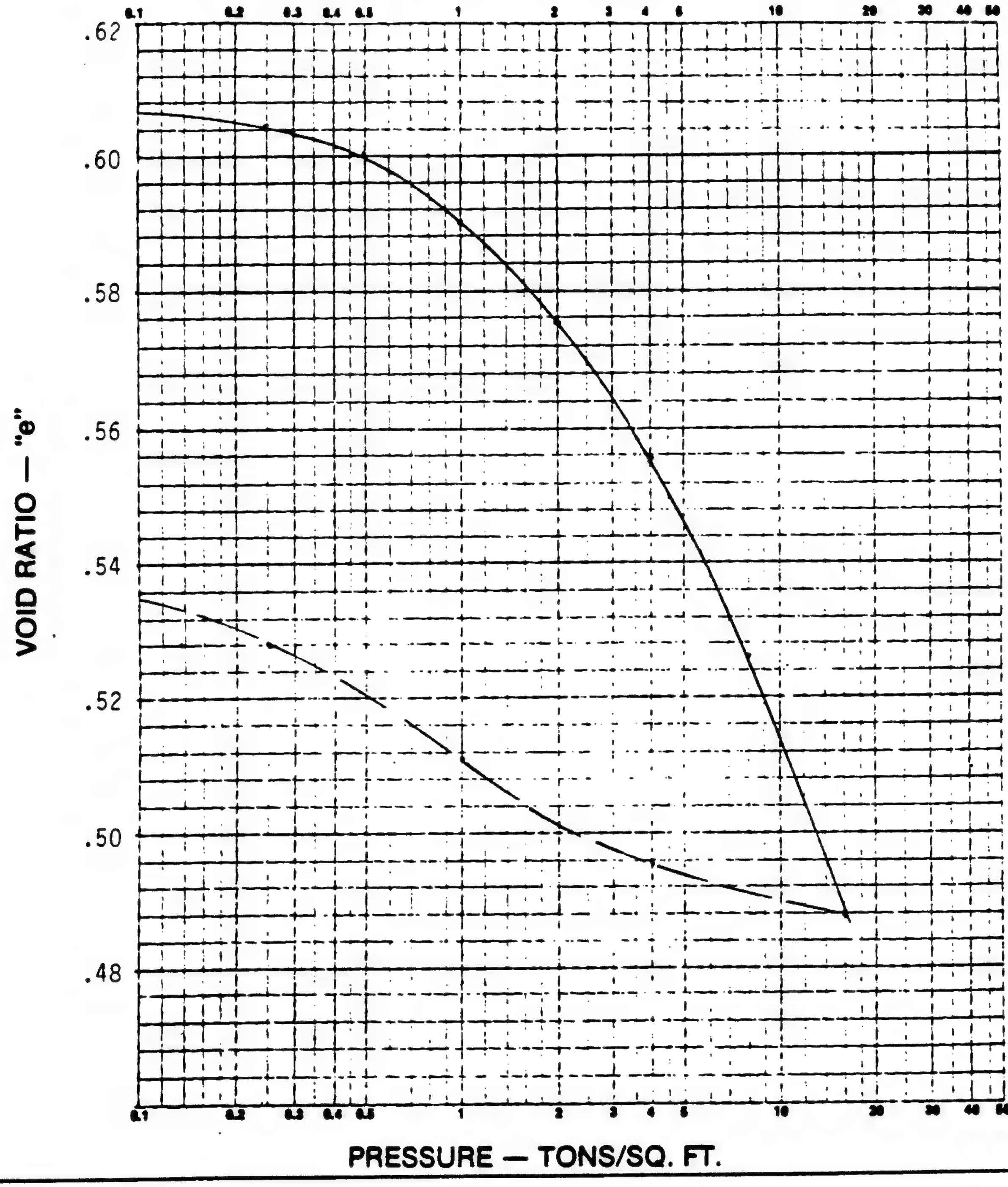






CONSOLIDATION TEST CURVE

VOID RATIO VS. PRESSURE



Project Chaska Creek Diversion

Job No. 4220 88-226 $G_S = 2.69$ Date March 1, 1988

Boring No. 87-72M Soil Type (ASTM: D2487) Lean Clay (CL)

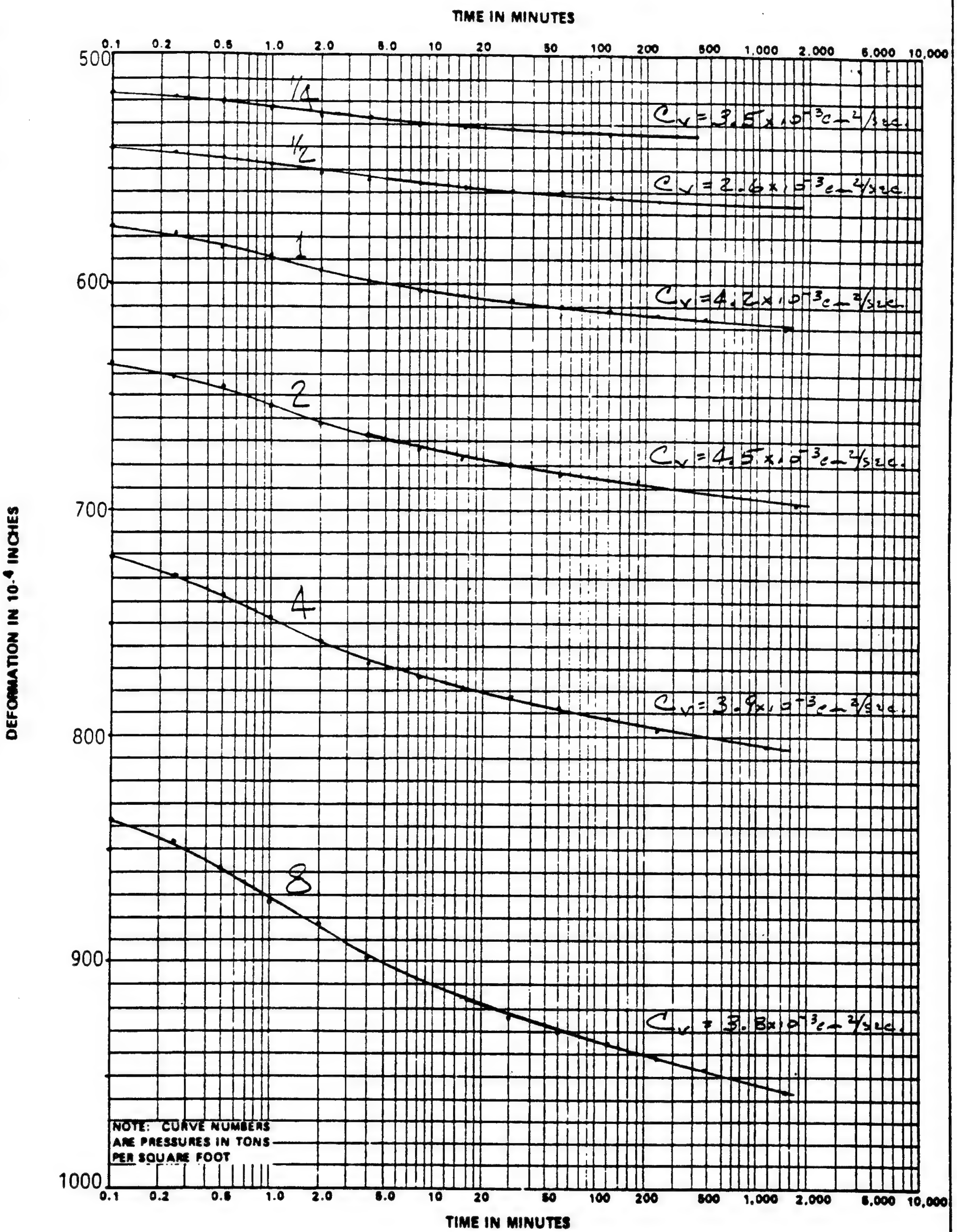
Sample No. 5 Original Moisture Content, Dry Density 22.9 % 104.6 PCF

Depth (FT.) 35-37 (Top) Liquid Limit 37.4 % Plastic Limit 20.3 %

Initial Sample Height (IN.) 0.797 Preconsolidation Pressure (Pc) 1.7 tsf

Sample Diameter (IN.) 2.505 Compression & Recompression Index: C_c 0.10 C_r

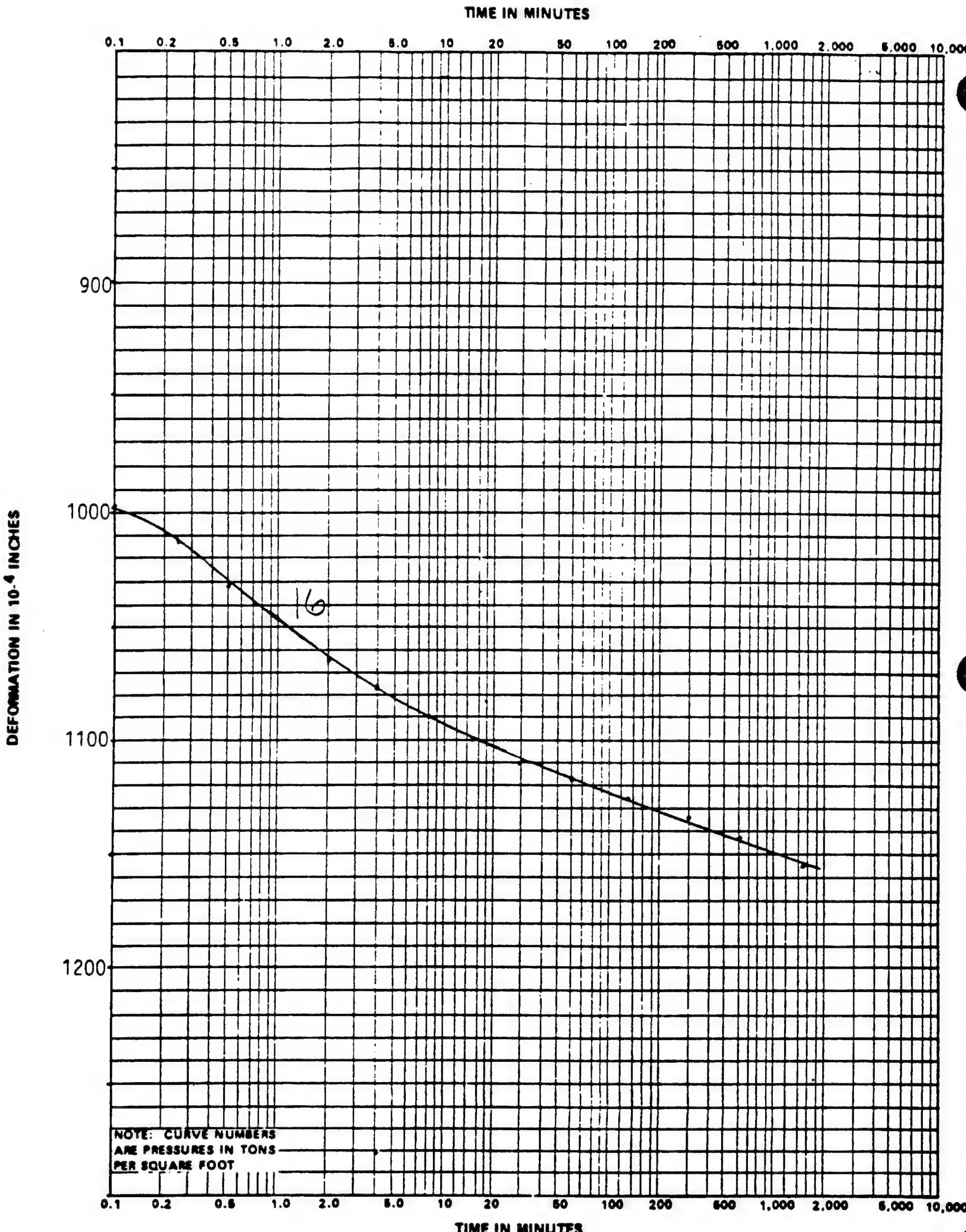
CONSOLIDATION TEST TIME CURVES



PROJECT: Chaska Creek Diversion			
JOB NO.: 4220 88-226	SAMPLE NO.: 5	BORING NO.: 87-72M	DEPTH: 35.0'-37.0' (Top)

SL-17 (77-8) 662 CROMWELL AVENUE twin city testing ST. PAUL, MN. 55114

CONSOLIDATION TEST TIME CURVES



PROJECT:	Chaska Creek Diversion						
JOB NO.:	4220 88-226	SAMPLE NO.:	5	BORING NO.:	87-72M	DEPTH:	35.0'-37.0' (Top)

SL-17 (77-8) 662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

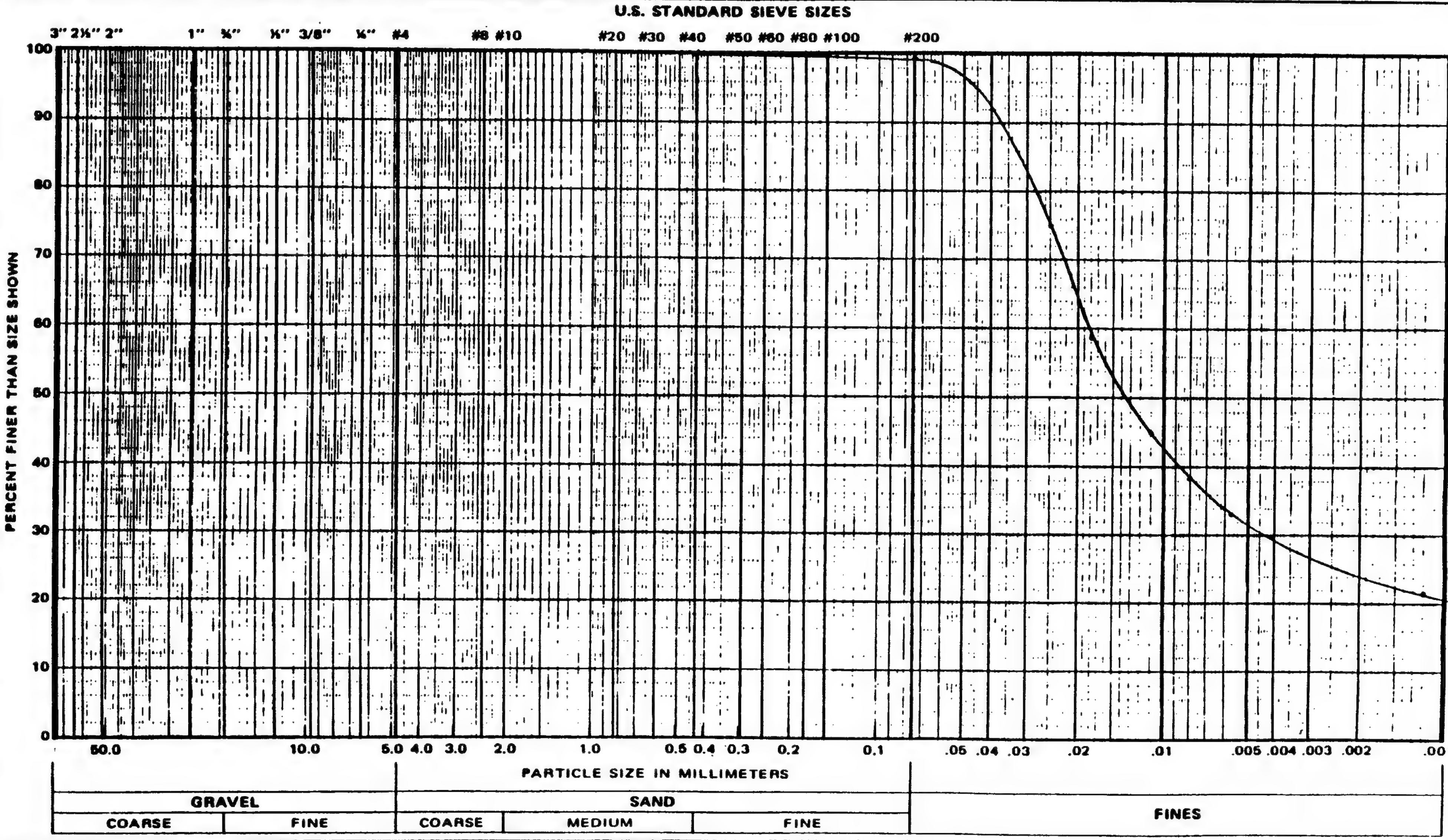
Figure C-182

GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE March 8, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-72M SAMPLE NO. 5 DEPTH (FT) 35-37 SOIL TYPE Lean Clay (CL)

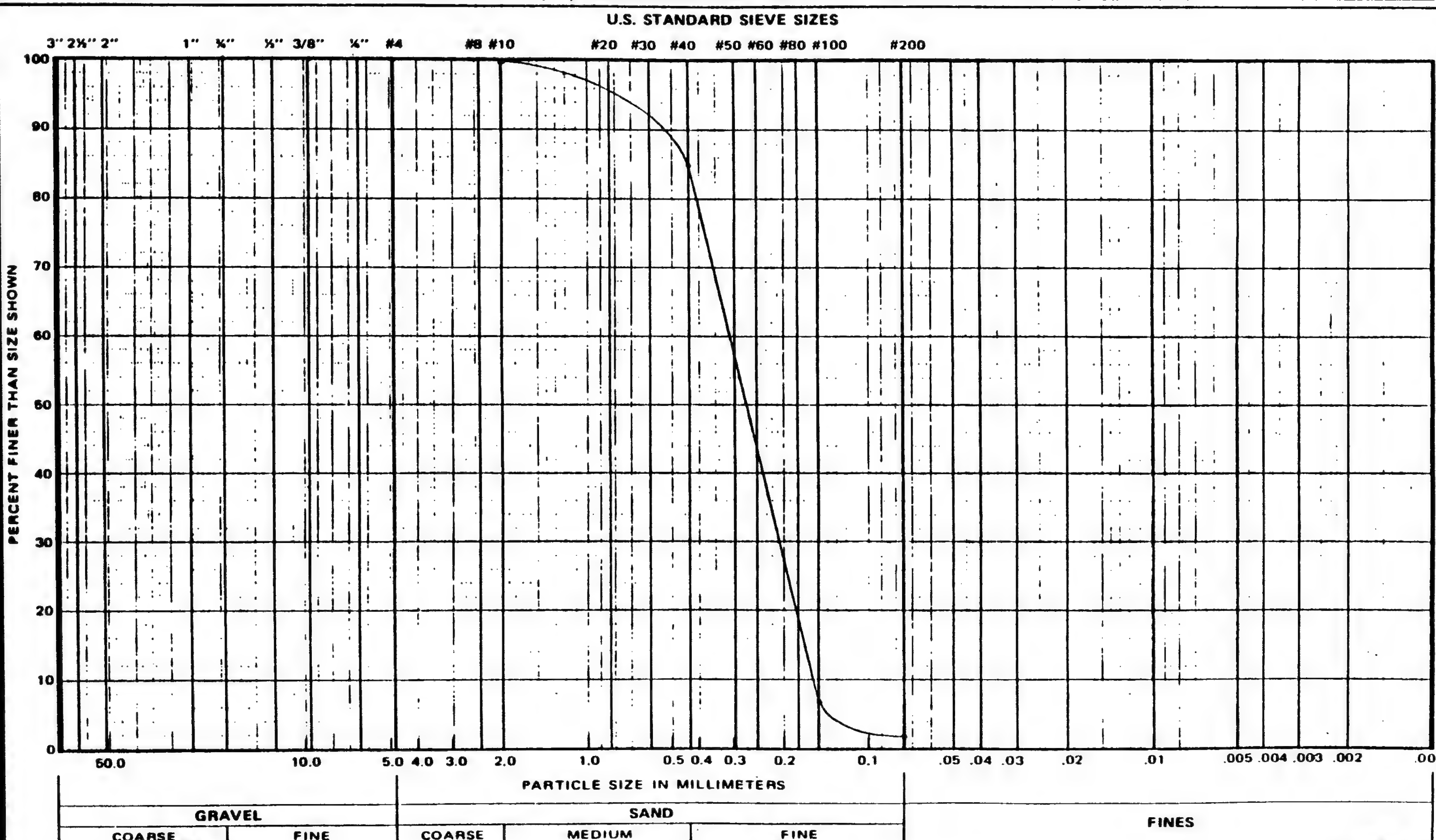


GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE February 17, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-72M SAMPLE NO. 6 DEPTH (FT) 15.4-15.9 SOIL TYPE Sand, Fine Grained (SP)



GRAIN SIZE DISTRIBUTION CURVE

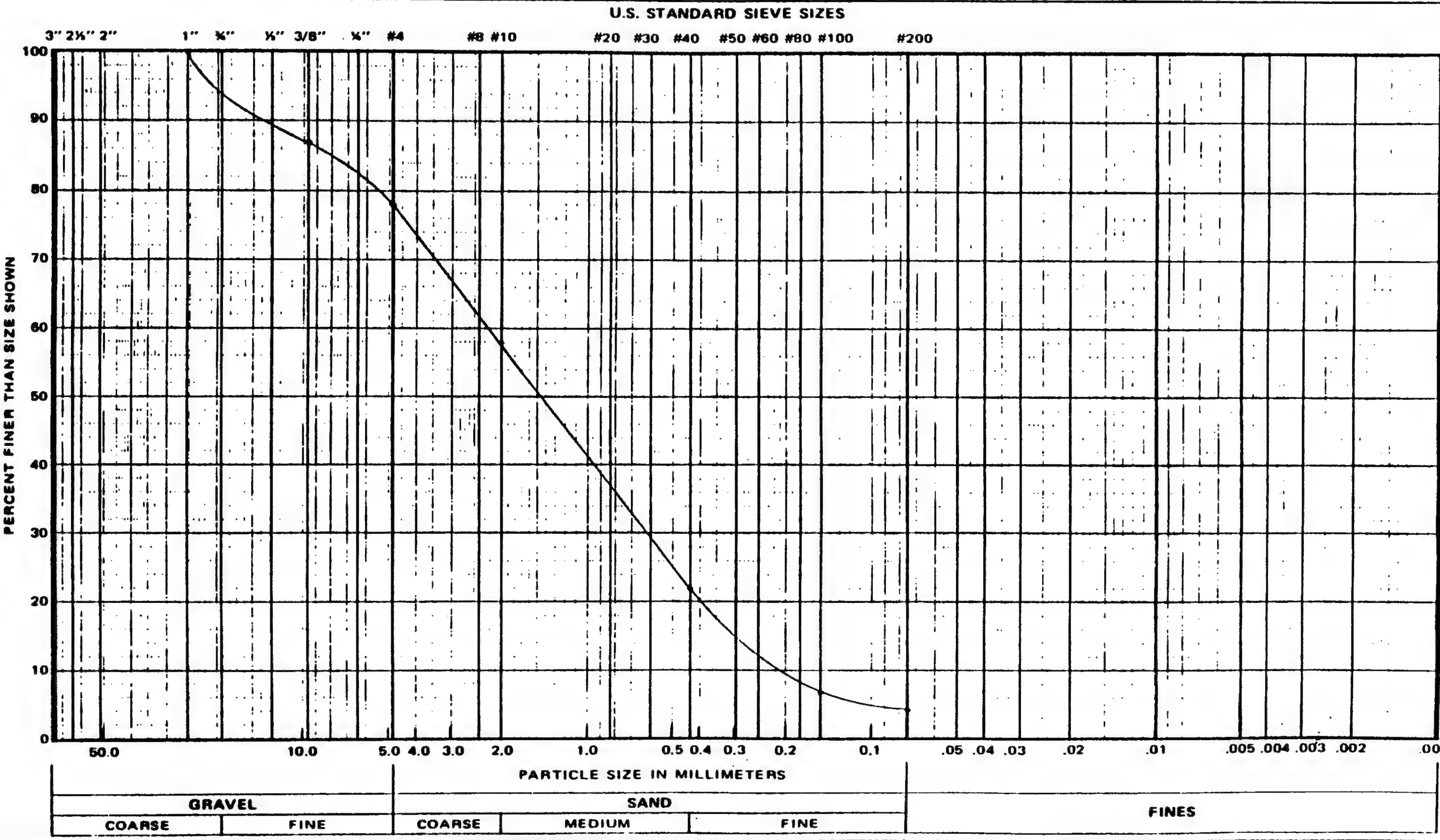
PROJECT Chaska Creek Diversion

DATE February 17, 1988

REPORTED TO St. Paul District Corps of Engineers

JOB NO. #4220 88-226

BORING NO. 87-72M SAMPLE NO. 15 DEPTH (FT) 50.3-50.9 SOIL TYPE Sand W/Gravel, Medium to Coarse Grained (SP)

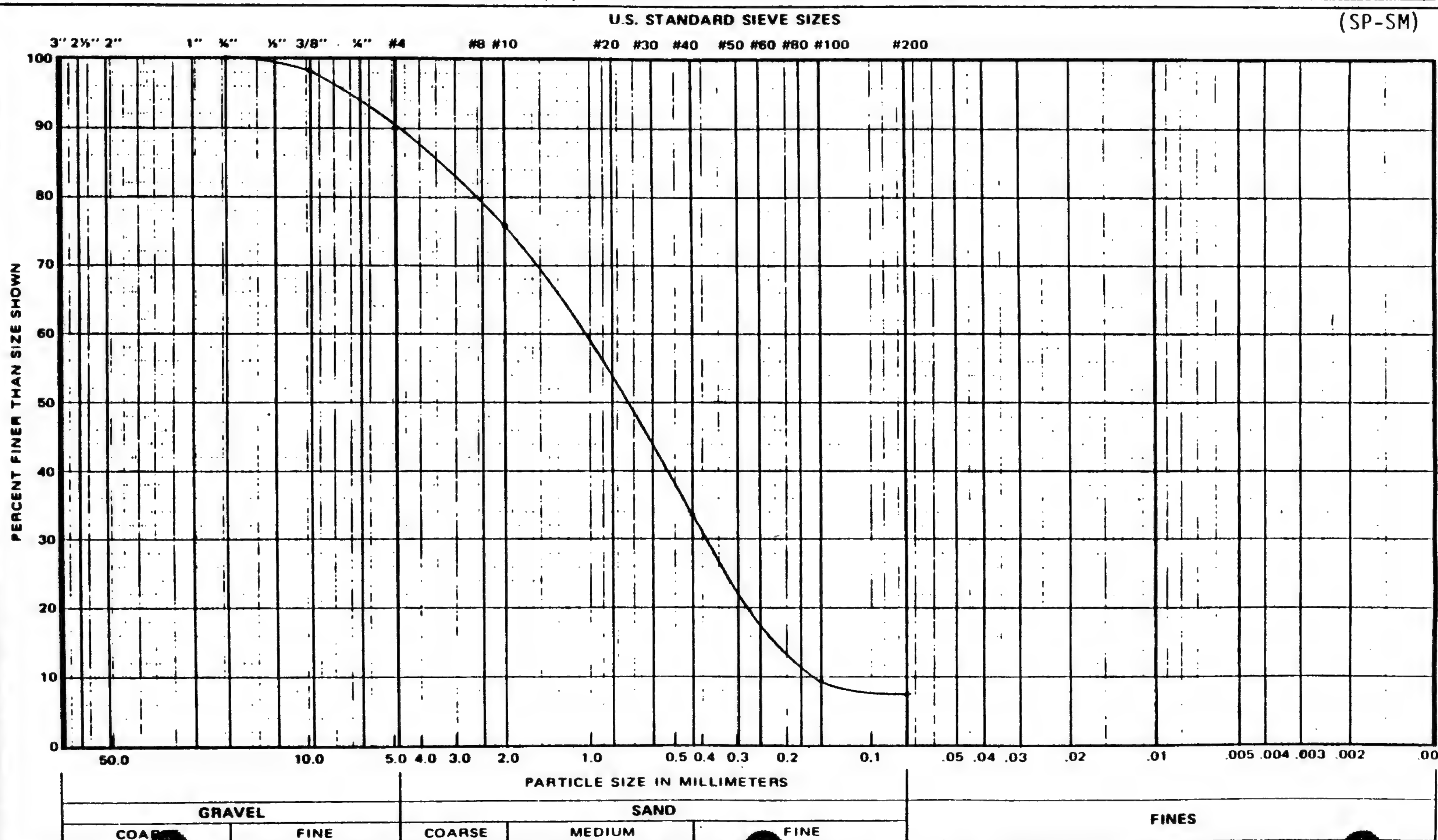


GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE February 17, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-72M SAMPLE NO. 18 DEPTH (FT) 66.2-66.9 SOIL TYPE Sand W/Silt & A Little Gravel, Medium Grained (SP-SM)

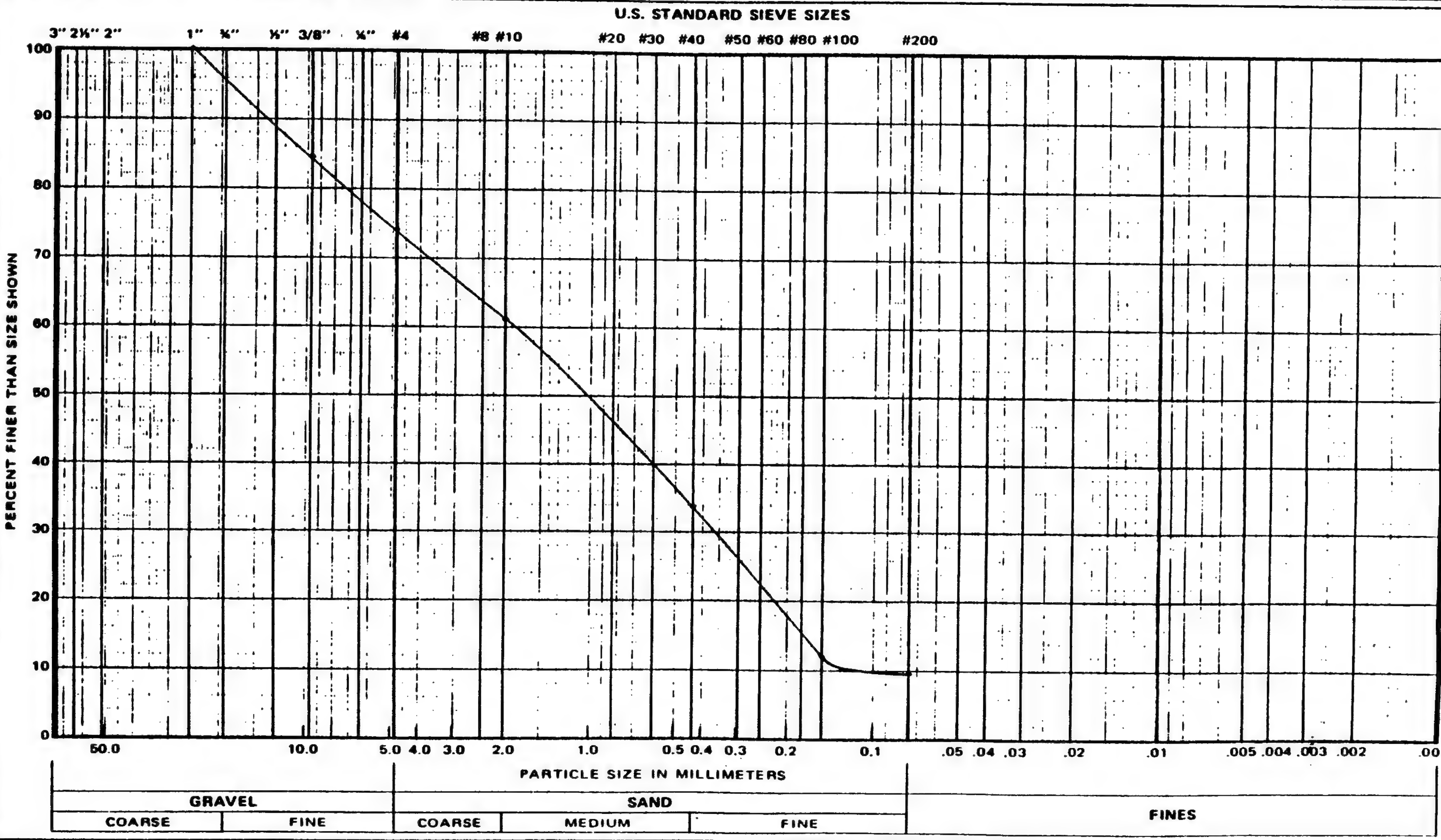


GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE February 17, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-72M SAMPLE NO. 24 DEPTH (FT) 86.2-86.8 SOIL TYPE Sand W/Silt & Gravel, Medium Grained (SP-SM)

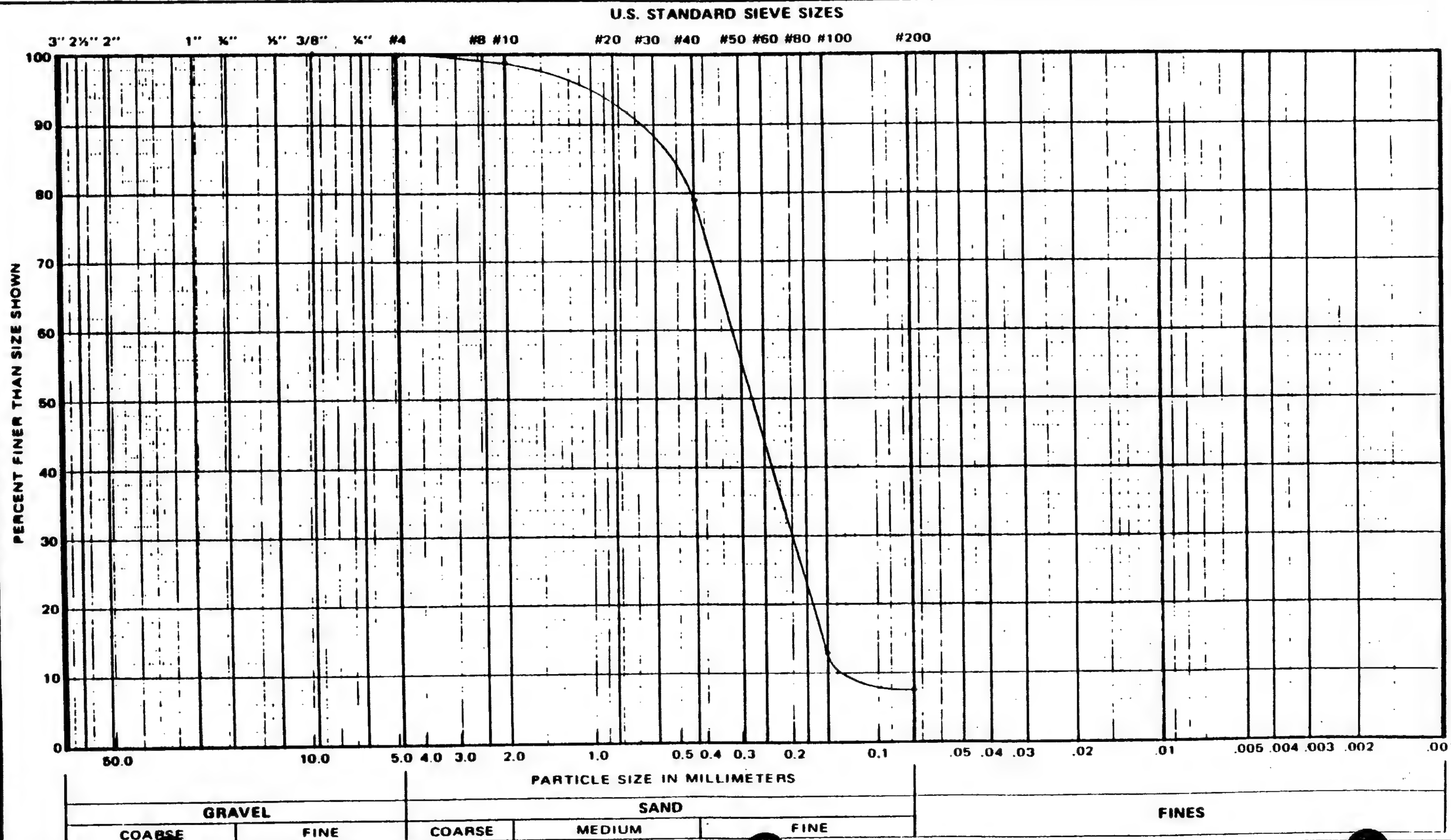


GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion **DATE** February 17, 1988

REPORTED TO St. Paul District Corps of Engineers **JOB NO.** #4220 88-226

BORING NO. 87-72M **SAMPLE NO.** 27 **DEPTH (FT)** 98.5-99.1 **SOIL TYPE** Sand W/Silt, Fine Grained (SP-SM)



662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

SL-21 (77-B)

INDEX TESTS

PROJECT: Chaska Creek Diversion DATE: March 9, 1988

REPORTED TO: St. Paul District Corps of Engineers JOB NO.: #4220 88-226

BORING #87-72M

SAMPLE NO.	DEPTH (ft)	SYMBOL	WATER CONTENT (%)	ATTERBURG LIMITS		
				Liquid Limit	Plastic Limit	Plasticity Index
9	26.3 - 26.8	(CL)	13.1	32.2	21.6	10.6
10	33.2 - 33.8	(CL)	18.0	40.0	20.1	19.9
11	38.1 - 38.8	(CL)	25.1	43.9	21.1	22.8
20	76.7 - 78.2	(CH)	24.7	60.1	23.1	37.0

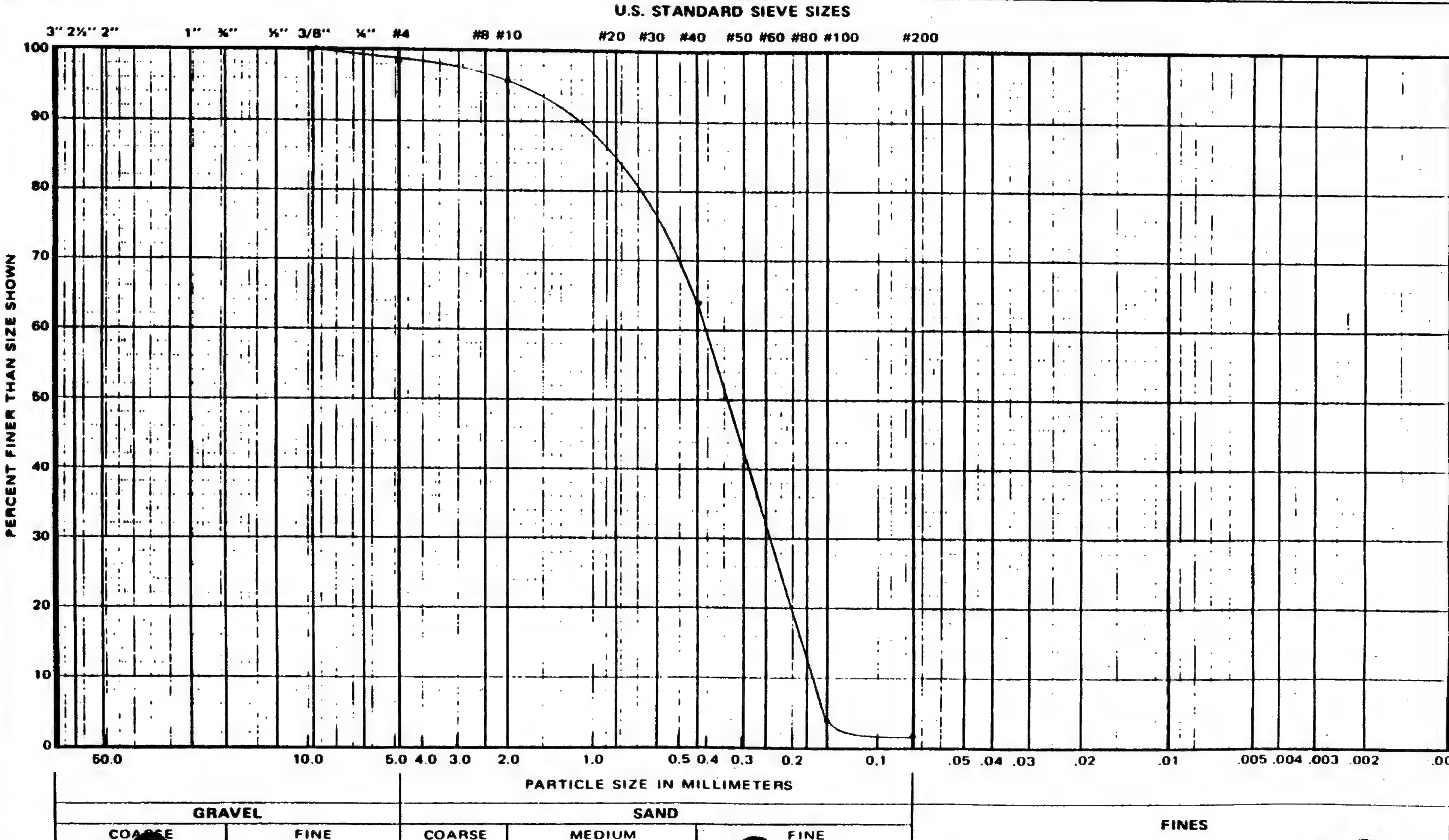
twin city testing corporation

GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion **DATE** February 6, 1988

REPORTED TO St. Paul District Corps of Engineers **JOB NO.** 4220 88-226

BORING NO. 87-75M **SAMPLE NO.** 1 **DEPTH (FT)** 3.2-3.9 **SOIL TYPE** Sand, Fine Grained (SP)



TRIAXIAL TEST DATA

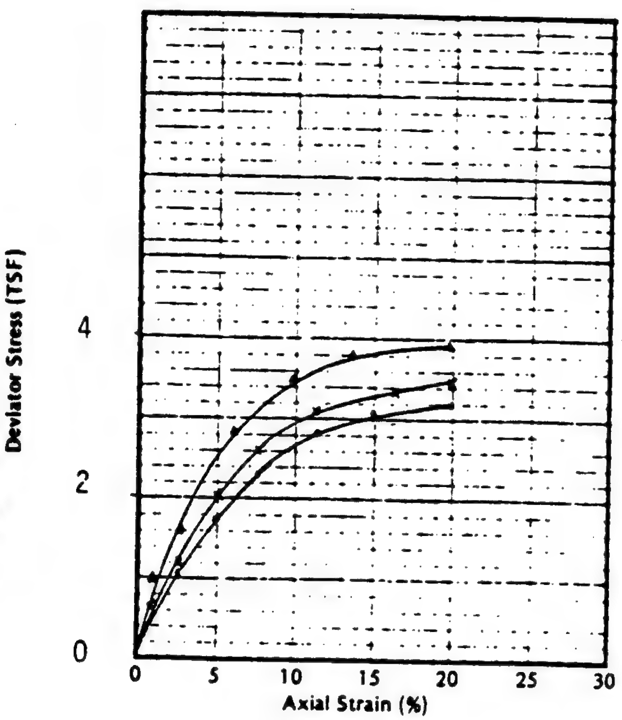
Date: August 17, 1988 Job No. 4220 88-226

Project: Chaska Creek Diversion

Boring No. 87-75M Sample No. 2 Depth (ft) 33-35 Type of Sample 5" Core

Soil Type: Lean Clay (CL) Type of Test: U-U

Remarks: Specimens trimmed to given sizes; lucite discs placed on each end; all drainage values closed; stressed to given strains at constant rate of 0.060"/min. Mohr circles at maximum deviater stress.



	SPECIMEN NO.	A	B	C	
Initial	Diameter (inches)	2.00	1.99	1.99	
	Height (inches)	4.06	4.02	4.08	
	Moisture Content (%)	25.3	24.5	24.4	
	Dry Density (PCF)	101.0	101.6	101.6	
	Saturation (%)				
	Void Ratio				
Before Shear	Moisture Content (%)				
	Dry Density (PCF)				
	Saturation (%)				
	Void Ratio				
	Back Pressure (TSF)				
	Minor Principal Stress TSF (σ_3)	1.0	2.0	4.0	
	Maximum Deviator Stress TSF $(\sigma_1 - \sigma_3)$	3.21	3.45	3.97	
	Ultimate Deviator Stress TSF $(\sigma_1 - \sigma_3)$	3.2	3.5	4.0	
LL	PI				
PL	G_s 2.68				
		•	×	▲	

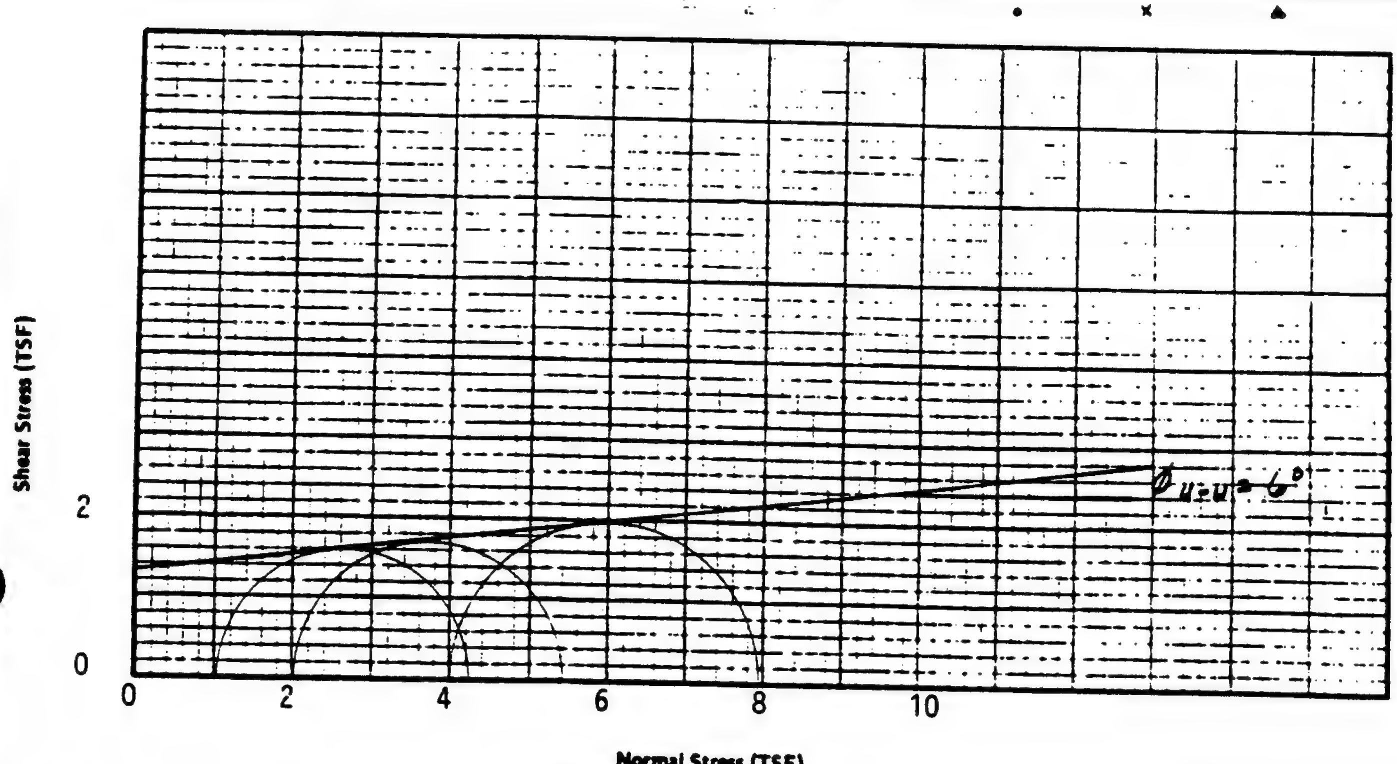


Figure C-191

TRIAXIAL TEST DATA

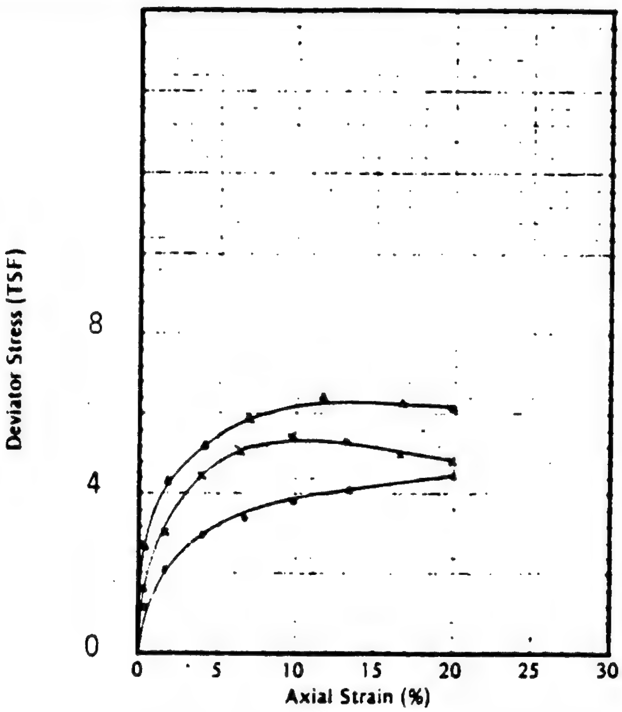
Date July 8, 1988 Job No. 4220 88-226

Project Chaska Circle Diversion

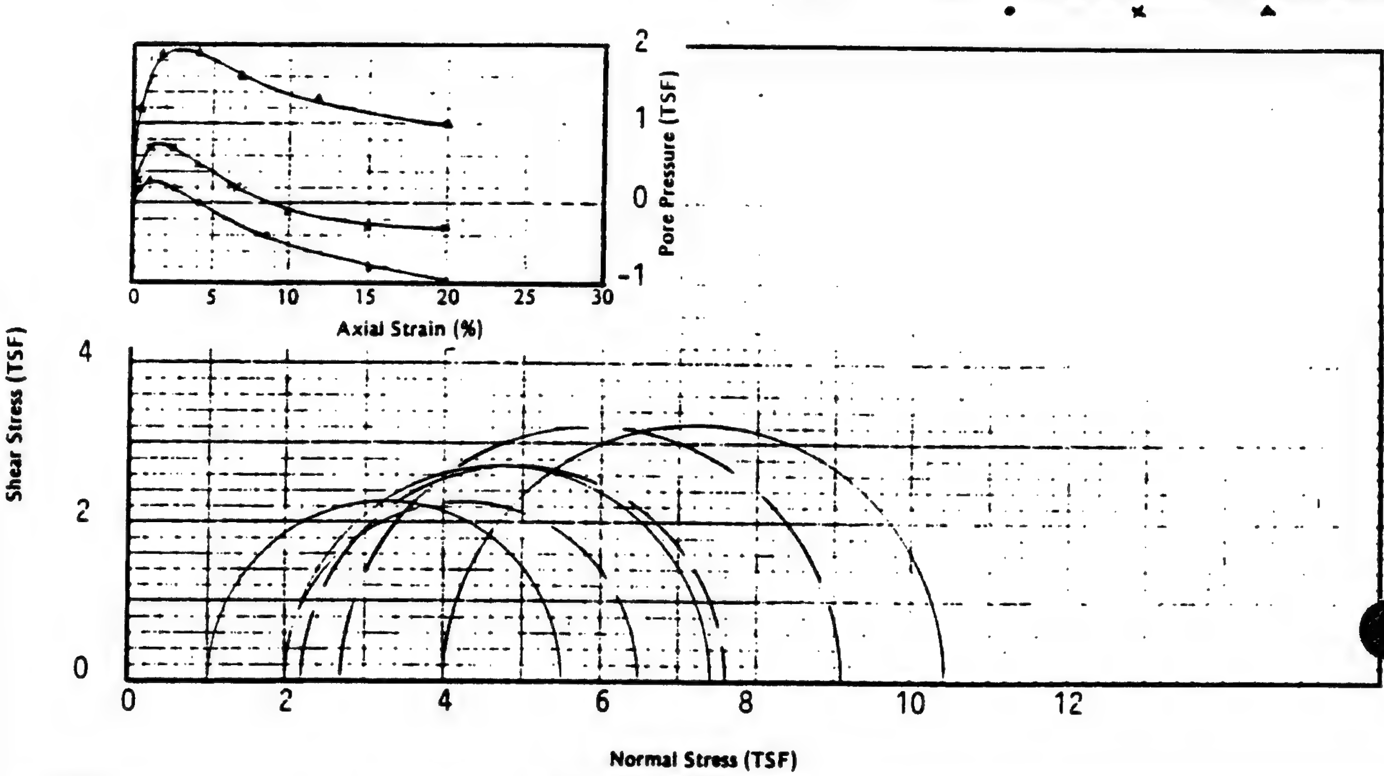
Boring No. 87-75M Sample No. 2 Depth (ft) 33-35 Type of Sample 5" Core

Soil Type Lean Clay (CL) Type of Test C-U w/pp

Remarks: Specimens trimmed to given sizes; radial (spiral) drainage strips applied; saturated for 30-36 days under low confinement; back pressure and effective confining pressures increased in stages, to values shown; then maintained for 21-27 days; stressed under constant strain rates of 0.006"/min; mohr circles at maximum stress ratio.

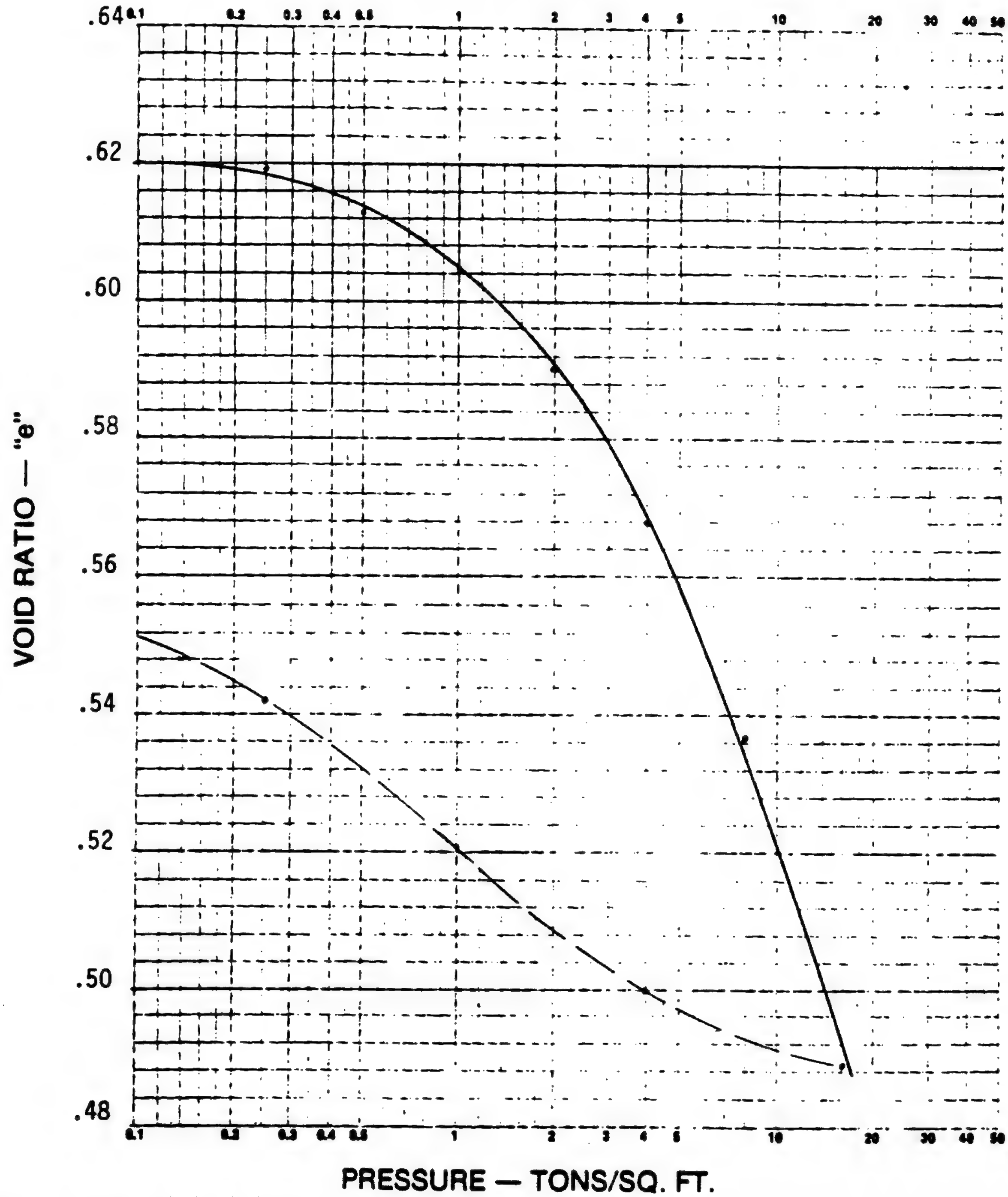


SPECIMEN NO.		A	B	C
Initial	Diameter (inches)	1.41	1.41	1.41
	Height (inches)	3.03	3.04	3.02
	Moisture Content (%)	22.9	24.3	25.6
	Dry Density (PCF)	101.1	99.7	98.1
	Saturation (%)	93.7	95.8	97.3
	Void Ratio	.65	.68	.71
Before Shear	Moisture Content (%)	23.3	23.2	23.4
	Dry Density (PCF)	102.7	103.0	102.7
	Saturation (%)	98.4	99.6	99.5
	Void Ratio	.63	.62	.63
	Back Pressure (TSF)	6.12	6.12	6.12
Minor Principal Stress TSF (σ_3)		1.00	2.00	4.00
Maximum Deviator Stress TSF ($\sigma_1 - \sigma_3$)		4.46	5.48	6.42
Ultimate Deviator Stress TSF ($\sigma_1 - \sigma_3$)		4.5	4.8	6.2
LL	PI			
PL	G_s 2.68			
		•	×	▲



CONSOLIDATION TEST CURVE

VOID RATIO VS. PRESSURE



Project CHASKA CREEK DIVERSION

Job No. 4220 88-226

Gs = 2.68

Date May 18, 1988

Boring No. 87-75M

Soil Type (ASTM: D2487) Lean clay (CL)

Sample No. 2

Original Moisture Content, Dry Density 24.1 % 103.1 PCF

Depth (FT.) 33-35

Liquid Limit 40.8 % Plastic Limit 15.2 %

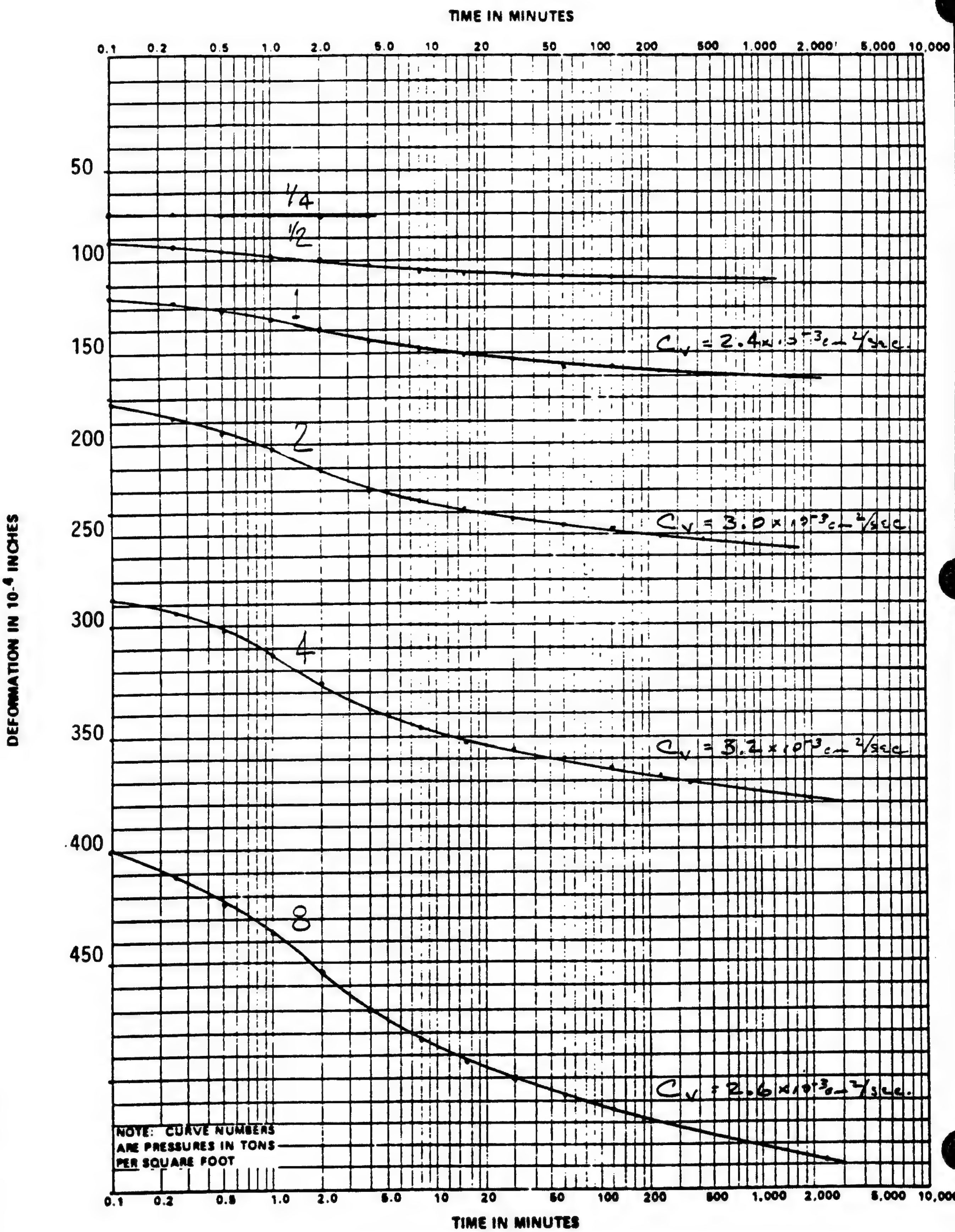
Initial Sample Height (IN.) 0.798

Preconsolidation Pressure (Pc) 1.9 TSF

Sample Diameter (IN.) 2.501

Compression & Recompression Index: C_c 0.11 C_r 0.02

CONSOLIDATION TEST TIME CURVES

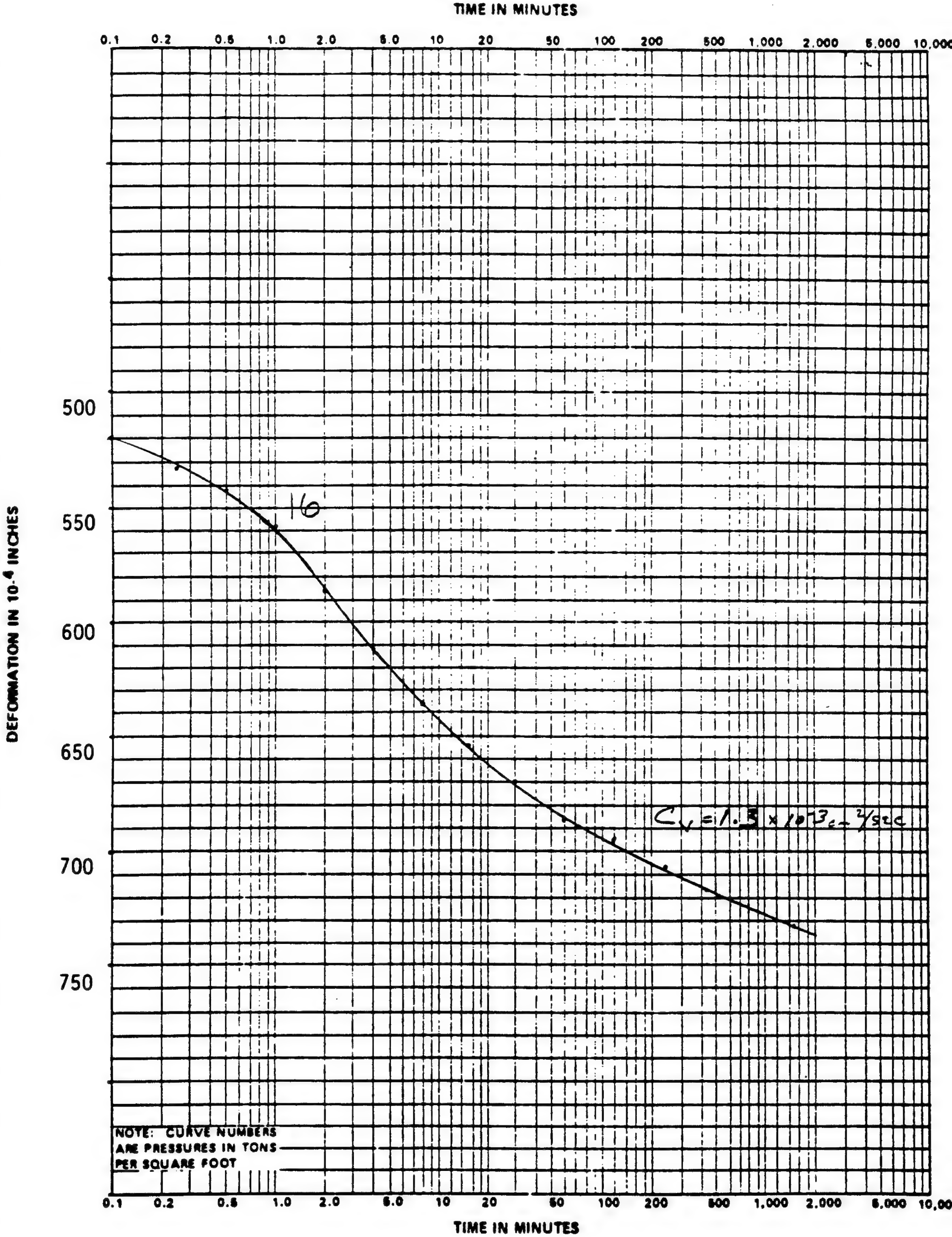


PROJECT: CHASKA CREEK DIVERSION

JOB NO.: 4220 88-226	SAMPLE NO.: 2	BORING NO.: 87-75M	DEPTH: 33'-35'

Figure C-194

CONSOLIDATION TEST TIME CURVES



PROJECT: CHASKA CREEK DIVERSION			
JOB NO.: 4220 88-226	SAMPLE NO.: 2	BORING NO.: 87-75M	DEPTH: 33'-35'

GRAIN SIZE DISTRIBUTION CURVE

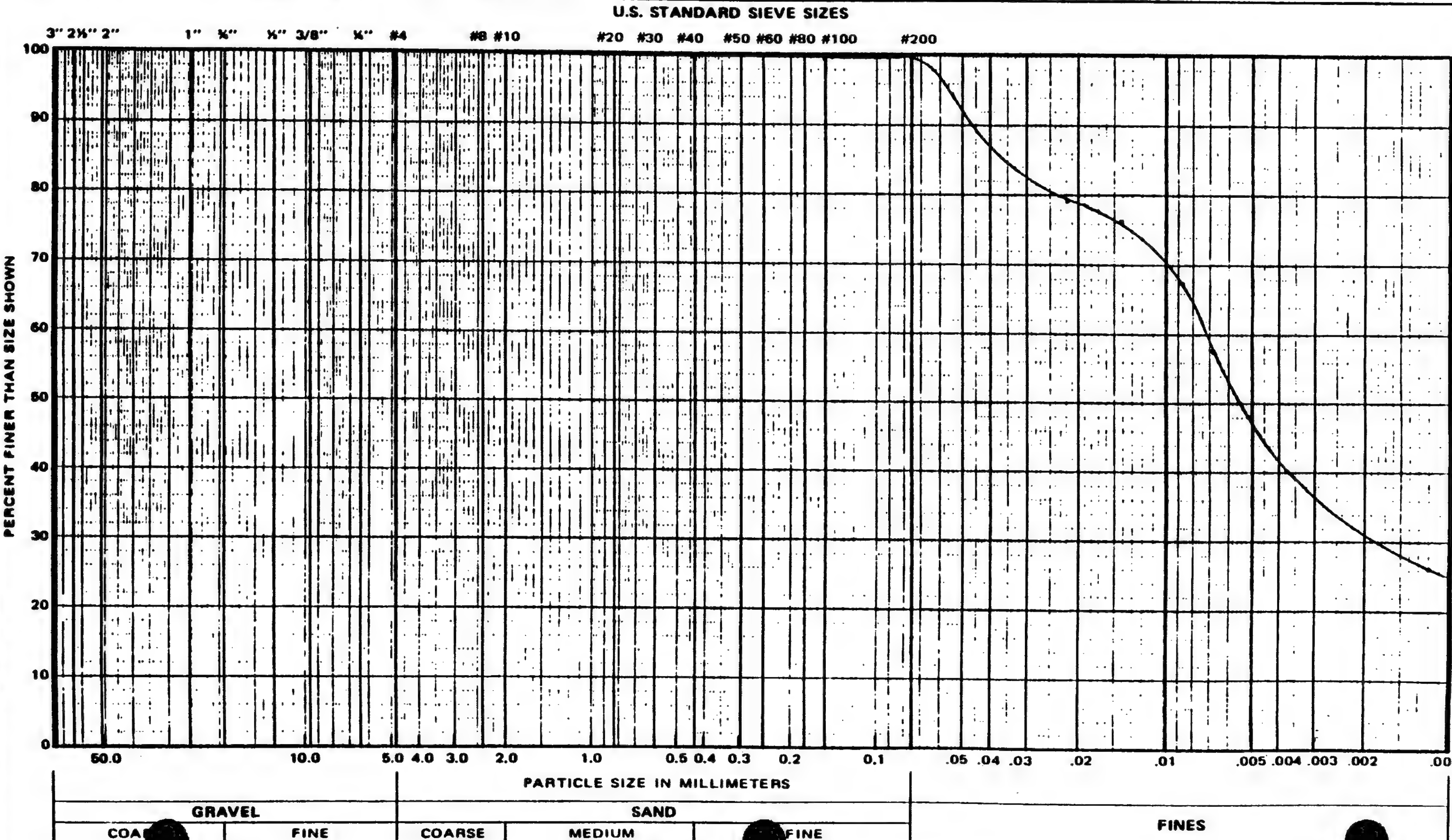
PROJECT CHASKA CREEK DIVERSION

DATE May 18, 1988

REPORTED TO ST PAUL DISTRICT CORPS OF ENGINEERS

JOB NO. 4220 88-226

BORING NO. 87-75M SAMPLE NO. 2 DEPTH (FT) 33-35 SOIL TYPE Lean clay (CL)



662 CROMWELL AVENUE twin city testing ST. PAUL, MN. 55114

GRAIN SIZE DISTRIBUTION CURVE

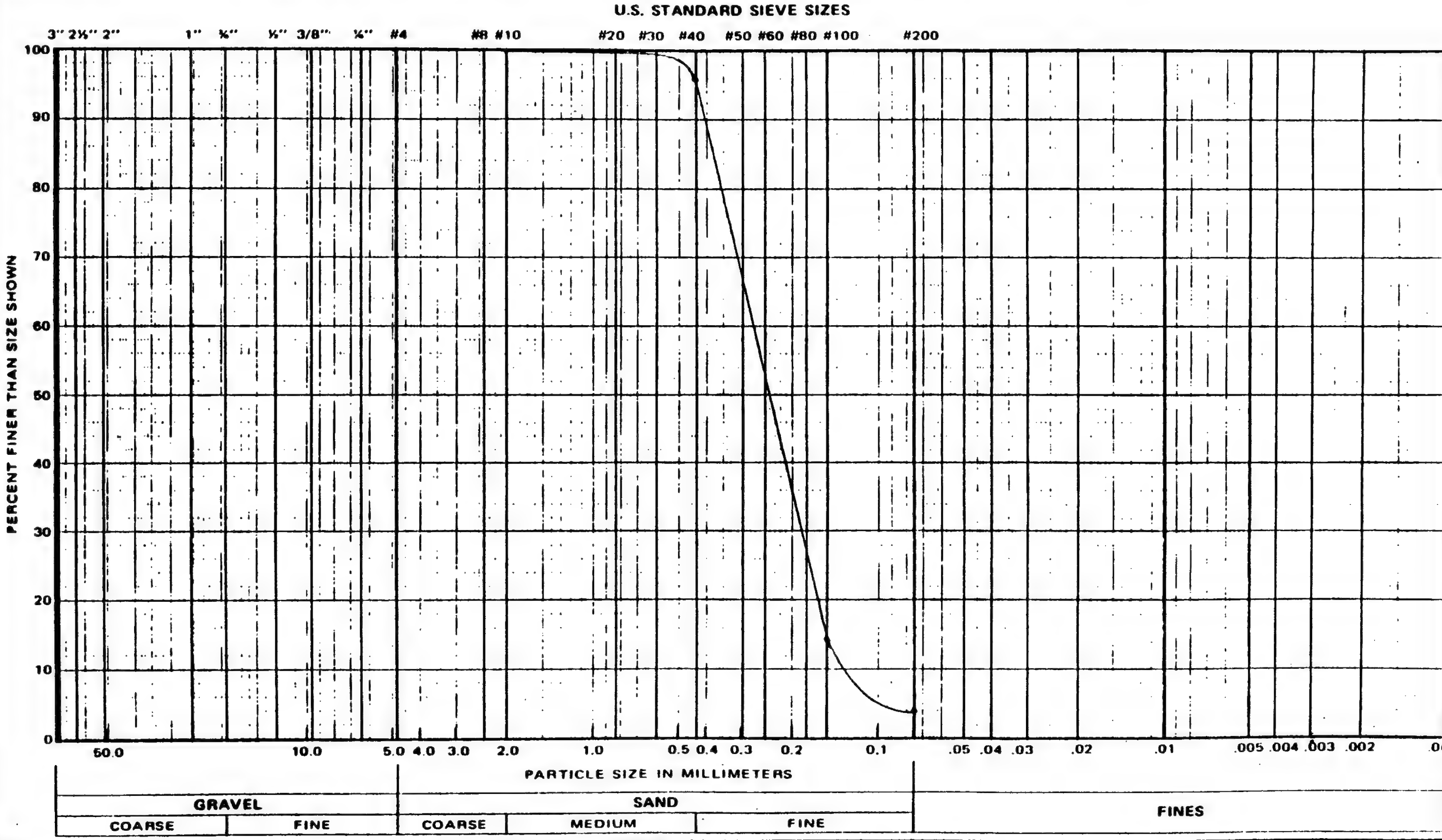
PROJECT Chaska Creek Diversion

DATE February 6, 1988

REPORTED TO St. Paul District Corps of Engineers

JOB NO. #4220 88-226

BORING NO. 87-75M SAMPLE NO. 3 DEPTH (FT) 10.2-10.7 SOIL TYPE Sand, Fine Grained (SP)



662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

SL-21 (77-B)

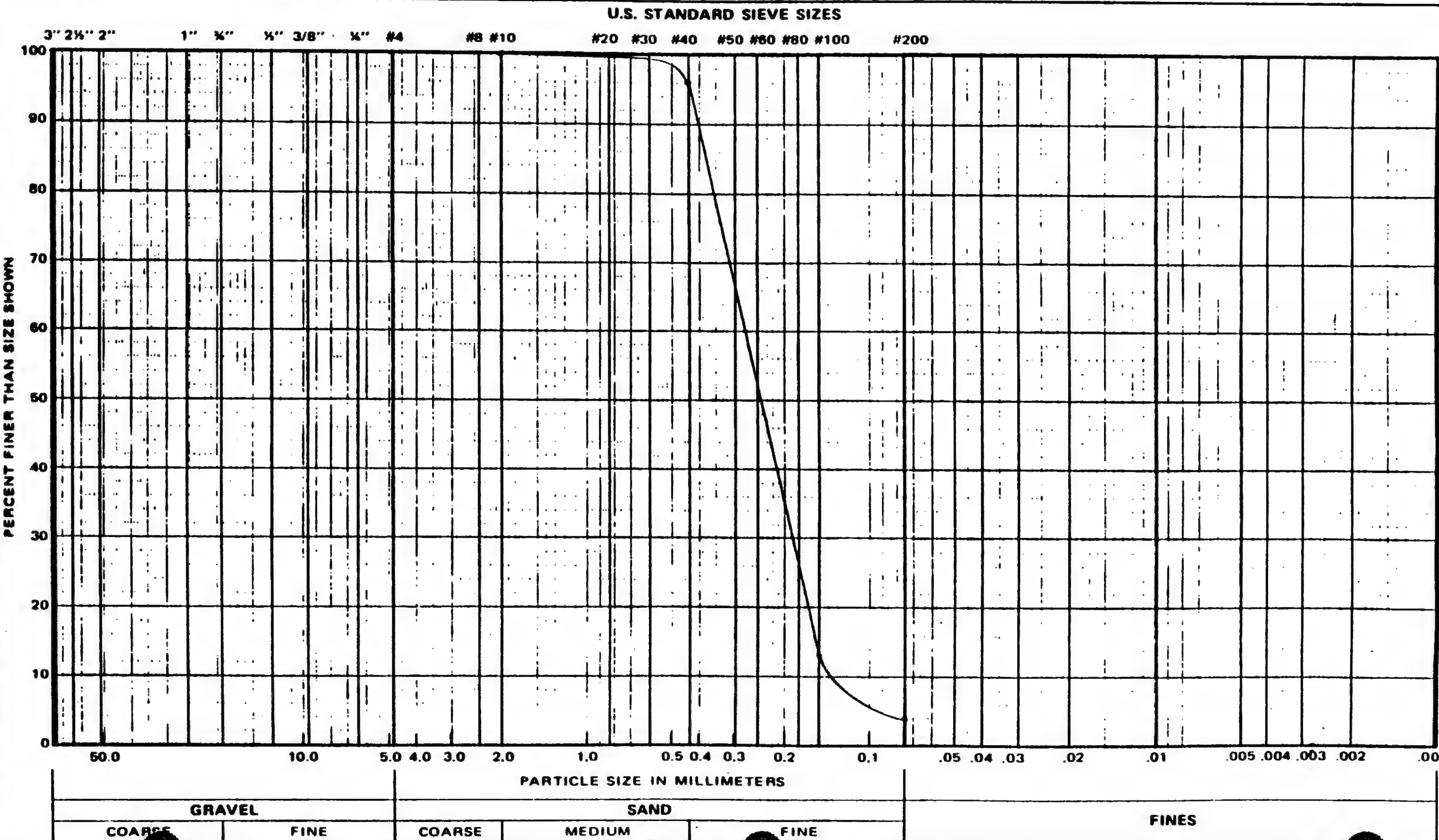
Figure C-197

GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE February 6, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-75M SAMPLE NO. 5 DEPTH (FT) 20.4-20.9 SOIL TYPE Sand, Fine Grained (SP)



INDEX TESTS

PROJECT: CHASKA CREEK DIVERSION DATE: May 26, 1988

REPORTED TO: ST PAUL DISTRICT CORPS OF ENGINEERS JOB NO.: 4220 88-226

Boring No. 87-75M

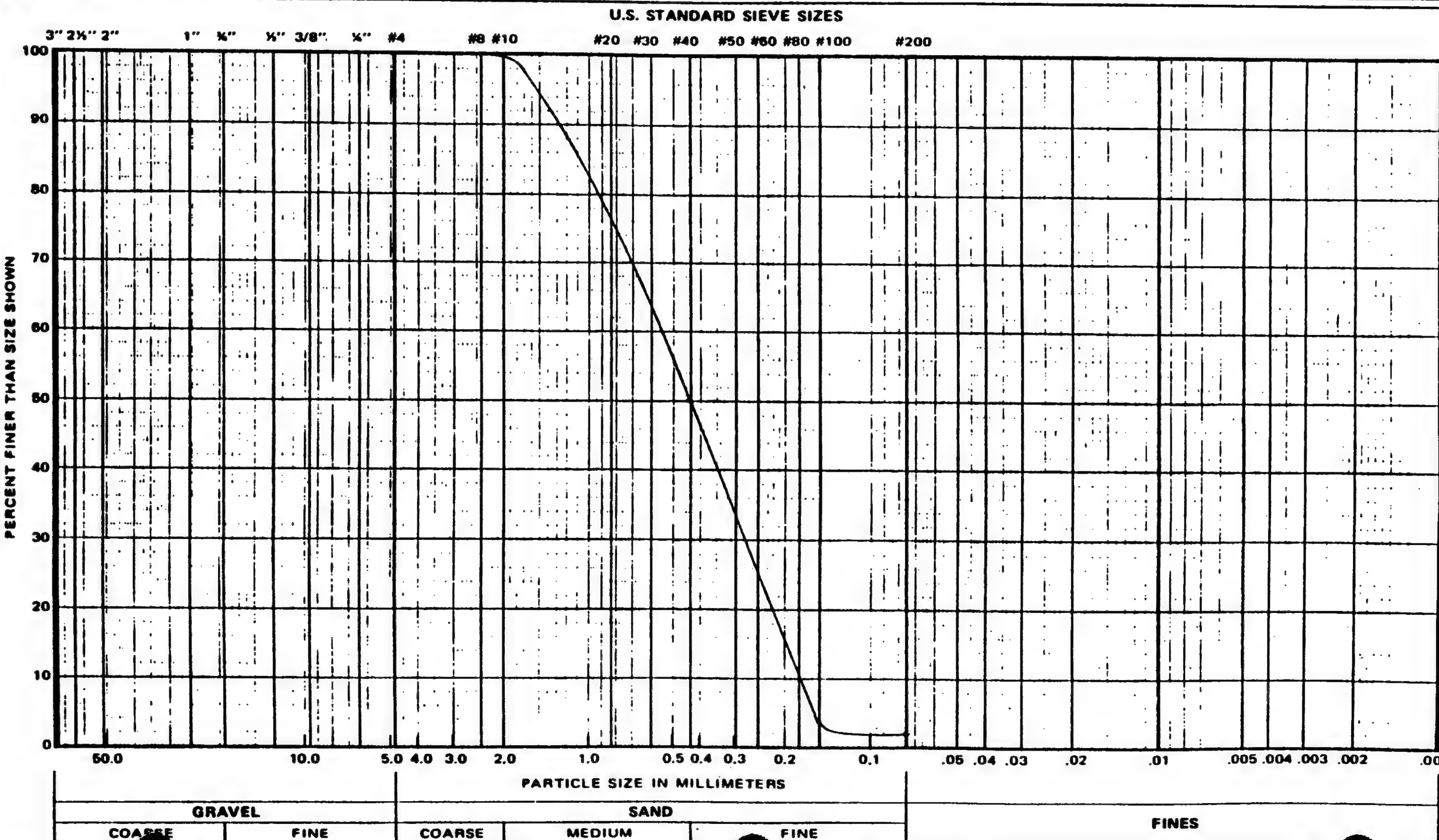
SAMPLE NO.	DEPTH (ft)	SYMBOL	WATER CONTENT (%)	ATTERBURG LIMITS Liquid Limit	Plastic Limit	Plasticity Index
6	25.4 - 25.9		24.2	34.0	18.7	15.3
7	30.3 - 30.8		25.0	35.6	20.2	15.3
8	35.1 - 35.6	(CL)	24.2	40.3	18.9	21.4
9	41.2 - 41.7		24.9	50.5	24.5	26.0

GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE February 6, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-76M SAMPLE NO. 2 DEPTH (FT) 5.3-5.8 SOIL TYPE Sand, Medium to Fine Grained (SP)



662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

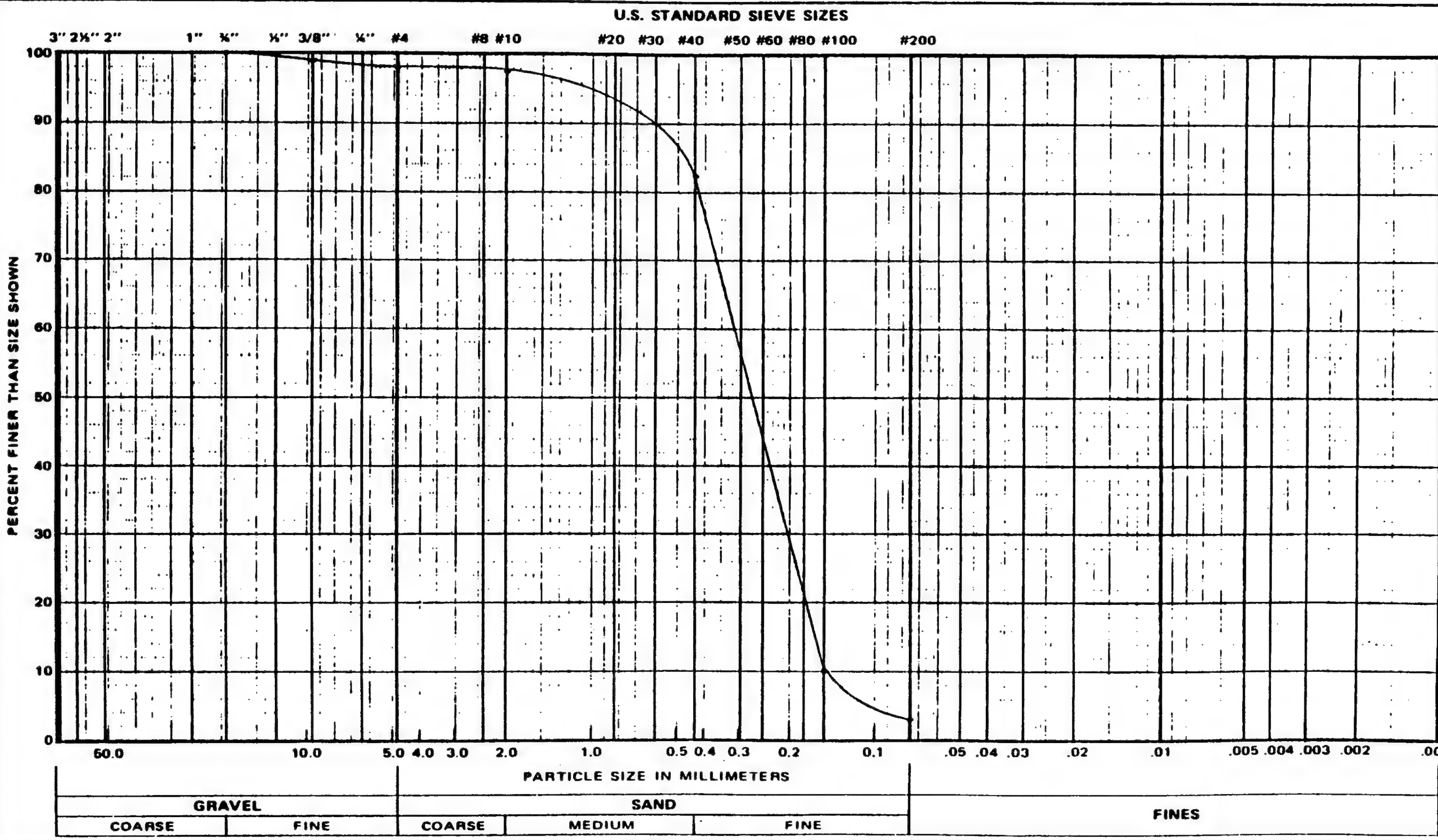
SL-21 (77-8)

GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE February 6, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-76M SAMPLE NO. 3 DEPTH (FT) 11.2-11.7 SOIL TYPE Sand W/A Little Gravel, Fine Grained (SP)



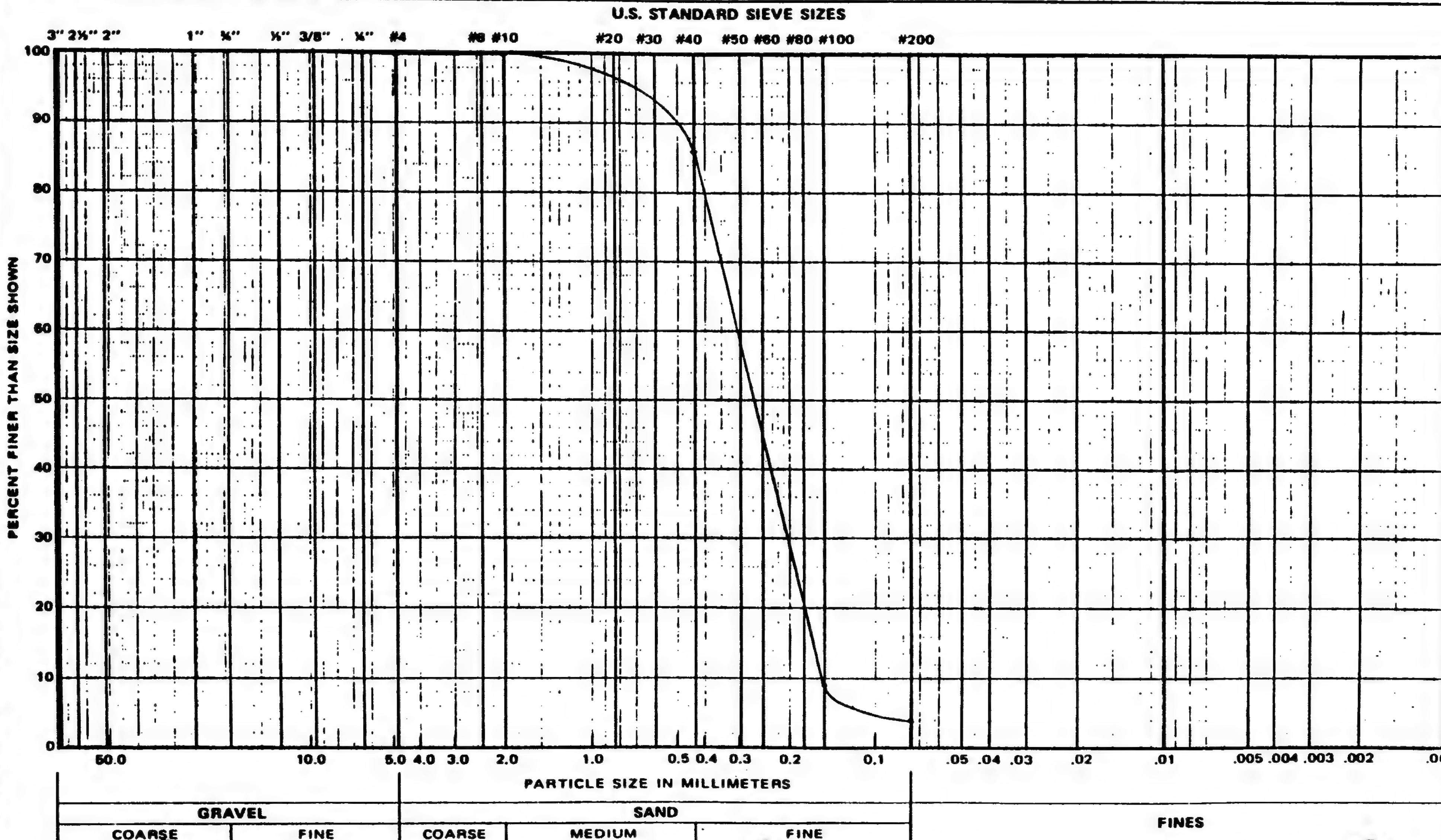
662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE February 6, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-76M SAMPLE NO. 4 DEPTH (FT) 13.2-13.8 SOIL TYPE Sand, Fine Grained (SP)

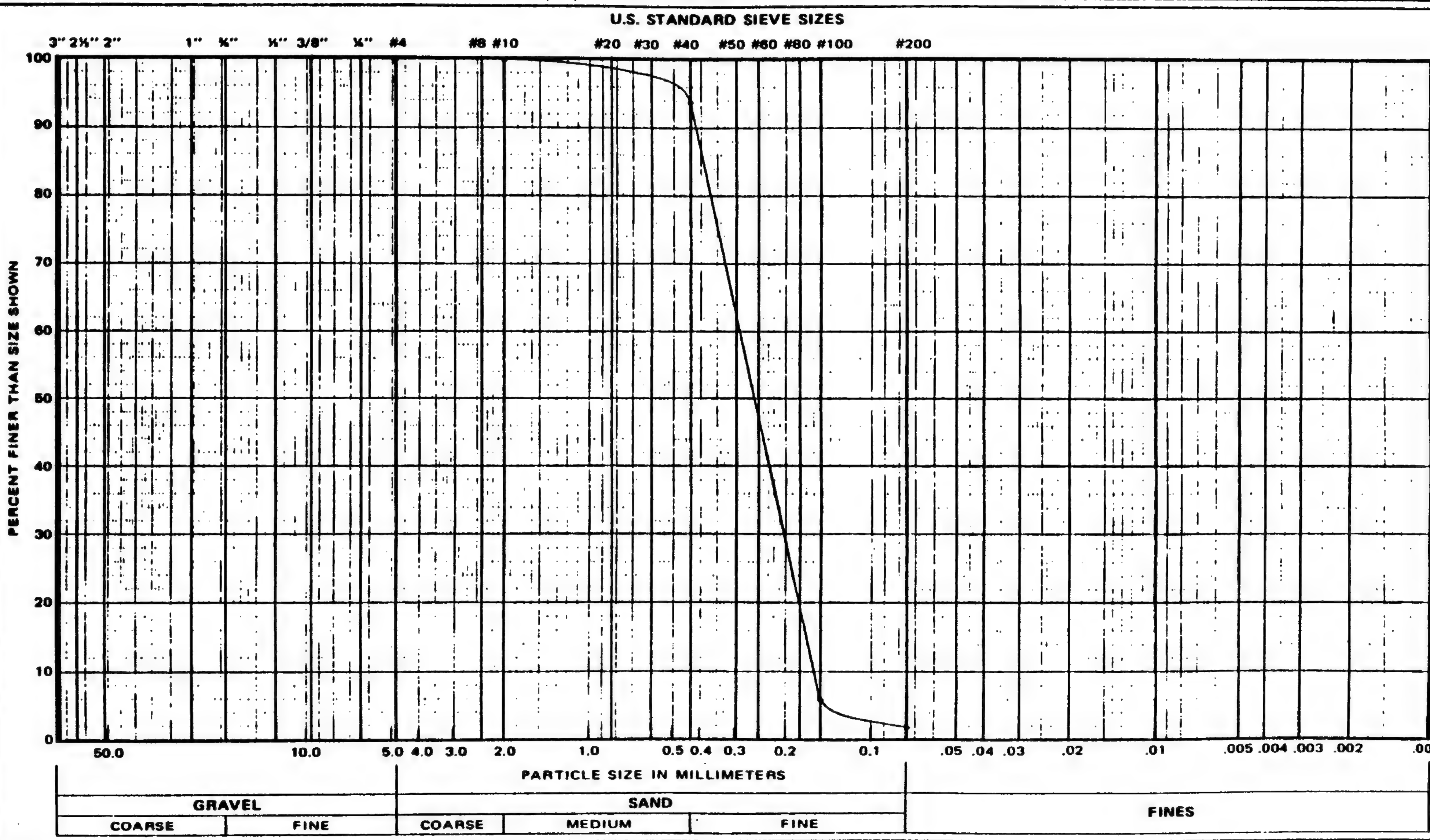


GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion — DATE February 6, 1988

REPORTED TO St. Paul District Corps of Engineers — JOB NO. #4220 88-226

BORING NO. 87-76M — SAMPLE NO. 5 — DEPTH (FT) 18.3-18.9 — SOIL TYPE Sand, Fine Grained (SP)

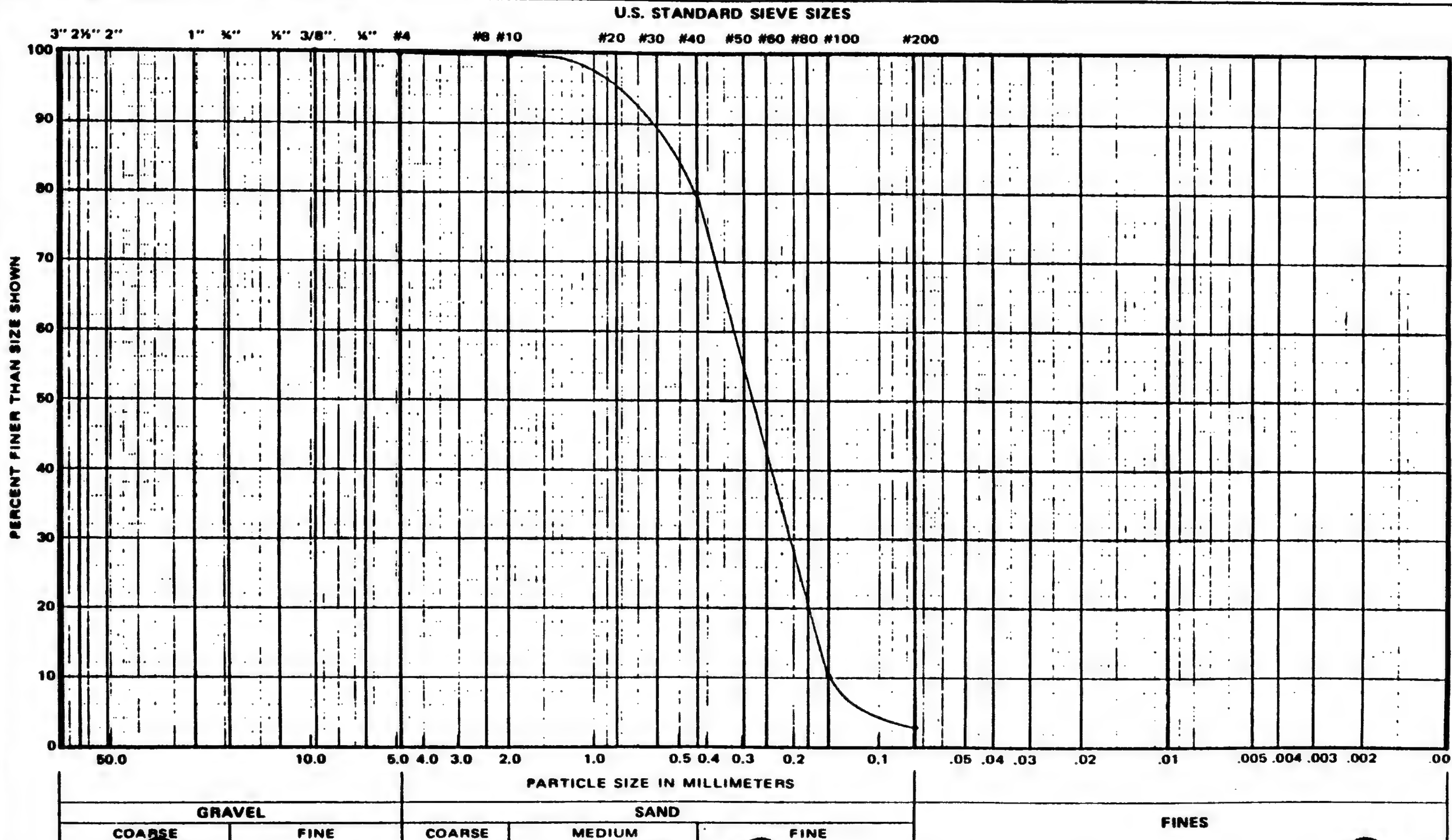


GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE February 6, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-76M SAMPLE NO. 6 DEPTH (FT) 21.1-21.6 SOIL TYPE Sand, Fine Grained (SP)



662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

SL-21 (77-8)

TRIAXIAL TEST DATA

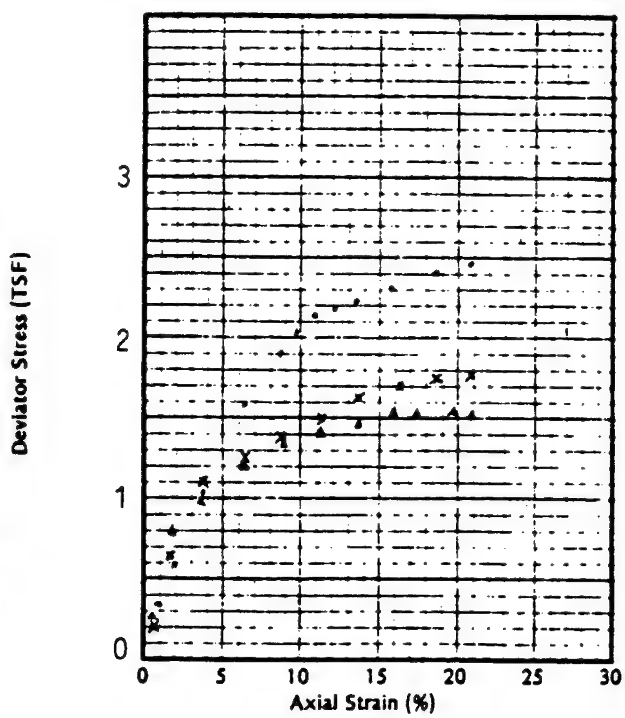
Date March 3, 1988 Job No. 4220 88-226

Project Chaska Creek Diversion

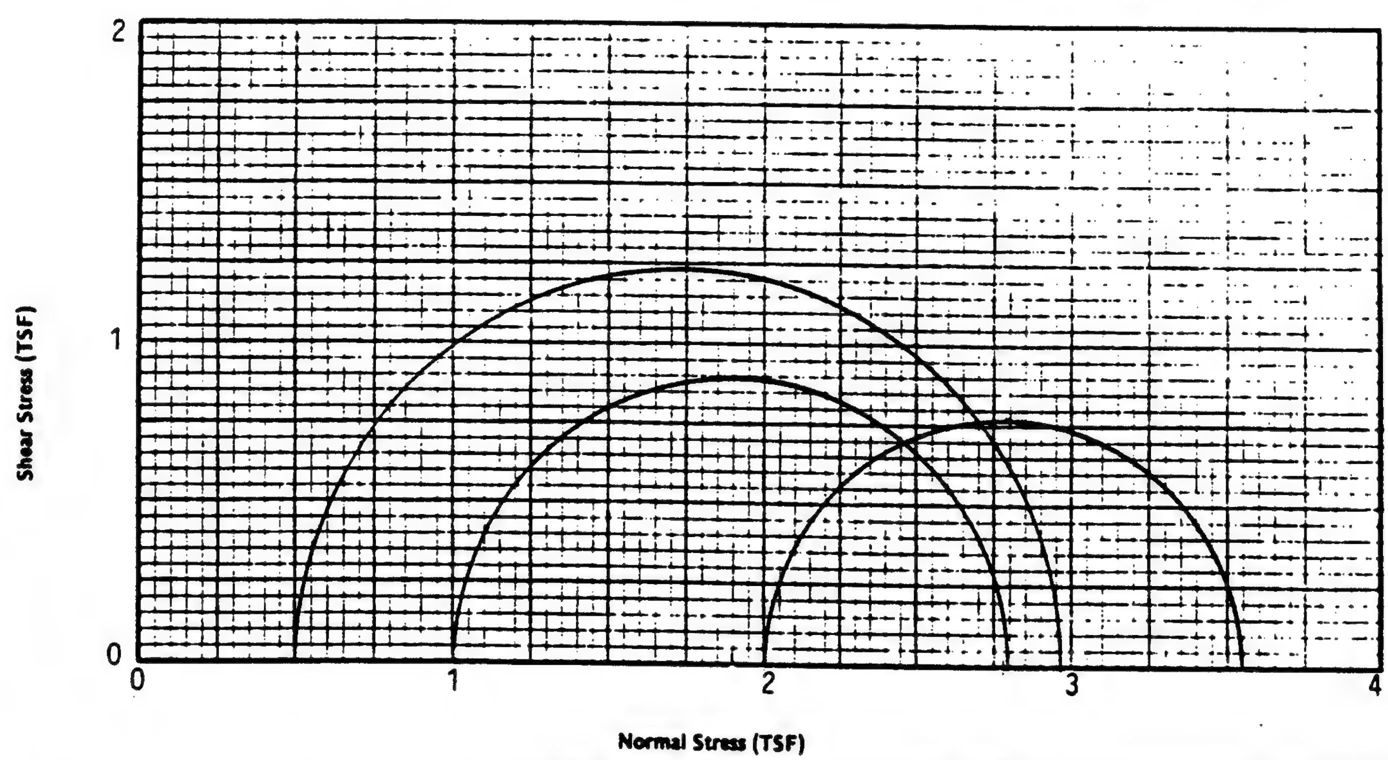
Boring No. 87-77M Sample No. 1 Depth (ft) 9.0-10.8 Type of Sample 5T

Soil Type Silt (ML) Type of Test U-U

Remarks: Specimens trimmed to given sizes; lucite discs placed on each end; all drainage valves closed; stressed to given strains at constant rate of 0.060"/min.; Mohr circles at maximum deviator stress.



	SPECIMEN NO.	A	B	C
Initial	Diameter (inches)	1.99	1.98	1.99
	Height (inches)	4.11	4.05	4.09
	Moisture Content (%)	24.5	25.5	22.9
	Dry Density (PCF)	101.7	101.0	99.8
	Saturation (%)	100	100	91.3
	Void Ratio	0.64	0.65	0.67
Before Shear	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)			
	Void Ratio			
	Back Pressure (TSF)	0	0	0
Minor Principal Stress TSF (σ_3)		0.50	1.00	2.00
Maximum Deviator Stress TSF ($\sigma_1 - \sigma_3$)		2.46	1.78	1.53
Ultimate Deviator Stress TSF ($\sigma_1 - \sigma_3$)				
LL 26.4	PI 2.5	•	×	▲
PL 23.9	G_s 2.66			



DIRECT SHEAR TEST

PROJECT Chaska Creek Diversion

REPORTED TO St. Paul District Corps of Engineers

DATE: March 4, 1988

JOB NO. 4220 88-226

BORING NO. 87-77M SAMPLE NO. 1 DEPTH (FT.) 9.0-10.8

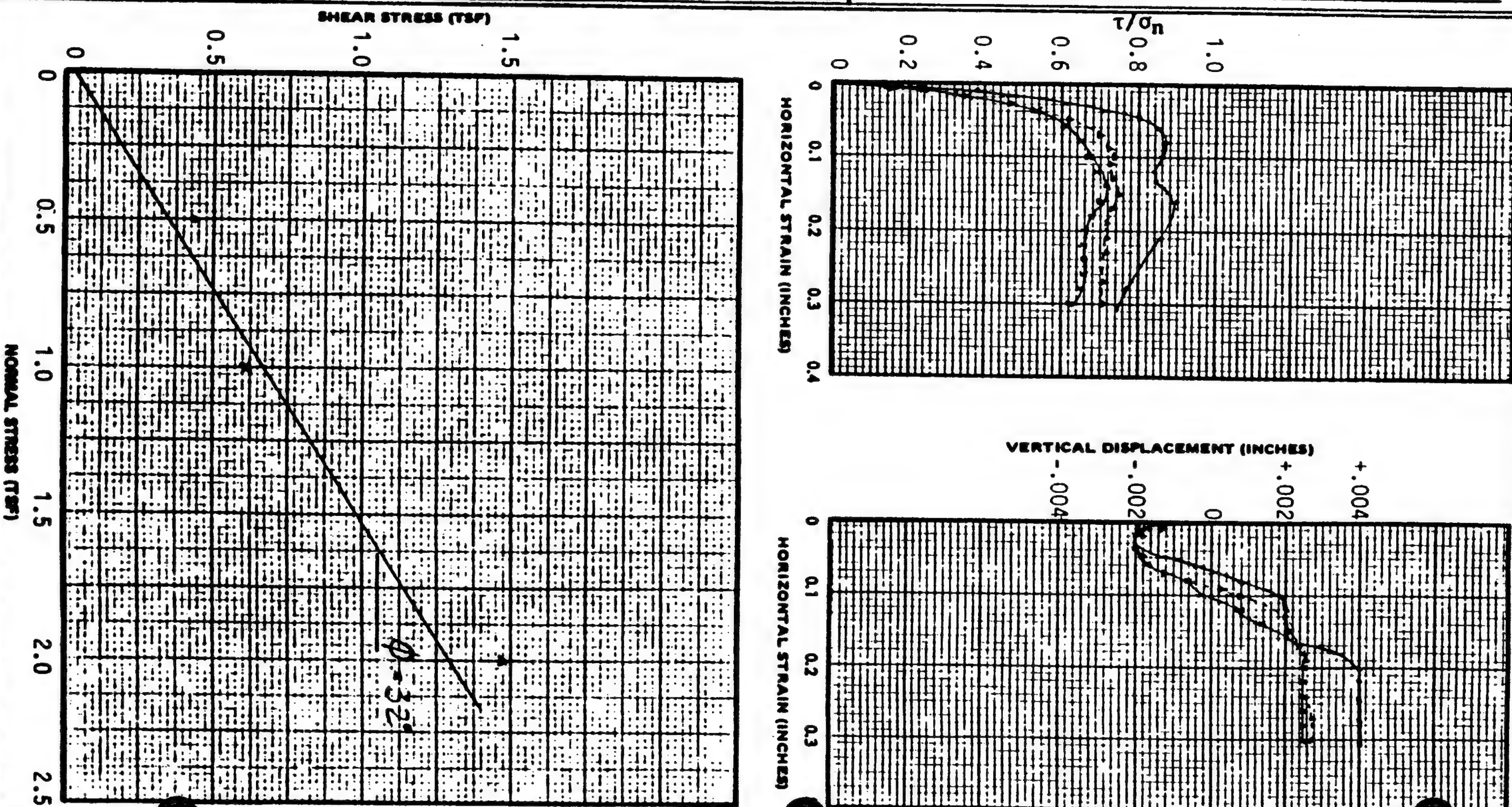
SAMPLE DIAMETER (INCHES) 2.500 SAMPLE HEIGHT (INCHES) 0.500

W.C. 23.0 22.6 23.6 Dry Density 105.2 106.0 103.7

LIQUID LIMIT (%) 26.4 PLASTIC LIMIT (%) 23.9 PLASTICITY INDEX 2.5

CLASSIFICATION (ASTM: D 2487) Silt (ML)

NOTES: Specimens trimmed to given sizes; consolidated under normal load, well into secondary compression; sheared to given strains at constant rate of 0.00064"/min.



INDEX TESTS

PROJECT: Chaska Creek Diversion

DATE: March 9, 1988

REPORT: St. Paul District Corps of Engineers

JOB NO.: #4220 88-226

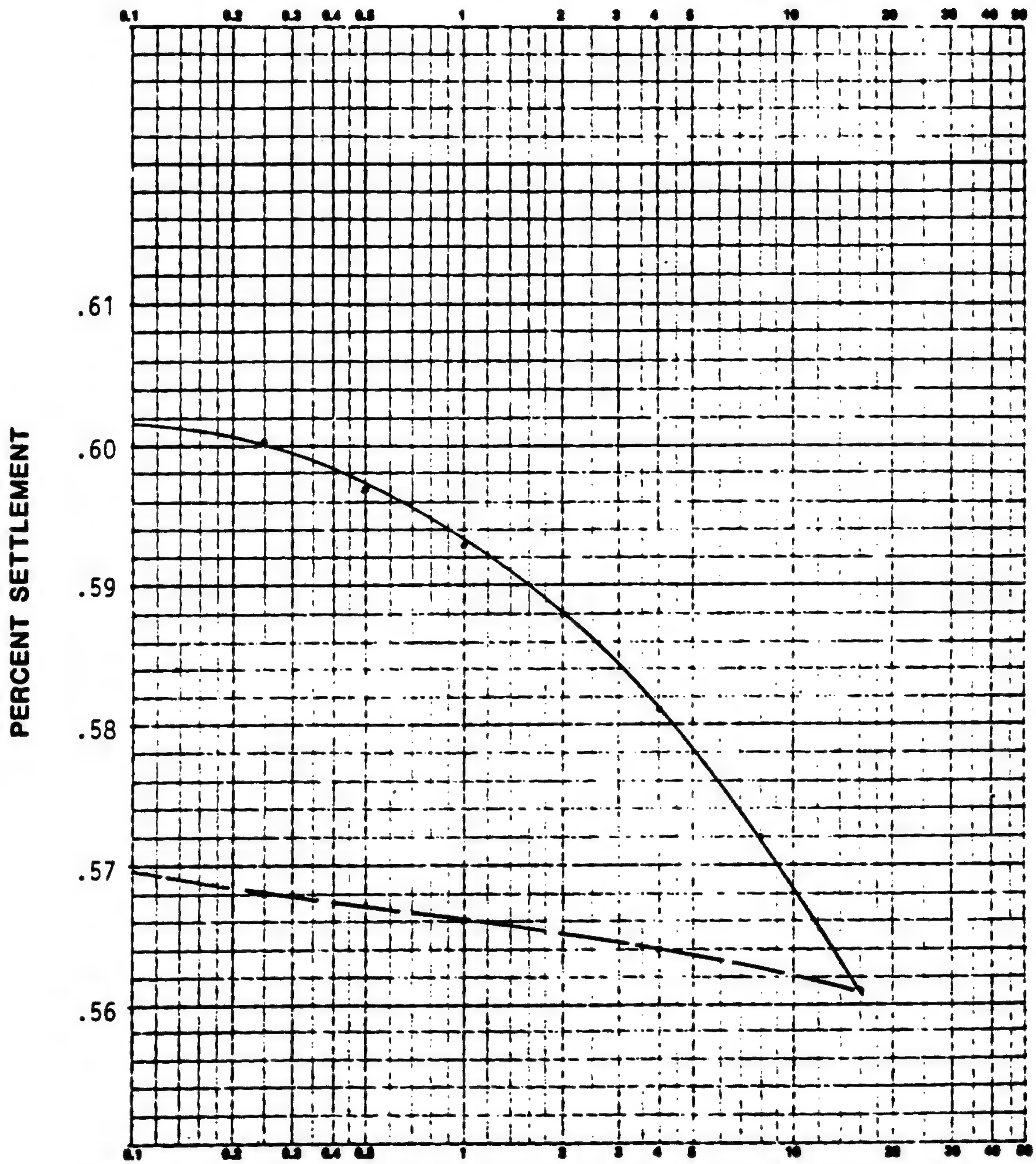
BORING: 77M

SAMPLE	DEPTH (ft)	SYMBOL	WATER CONTENT (%)	ATTERBURG LIMITS		
				Liquid Limit	Plastic Limit	Plasticity Index
2	3.2-3.7	(CL)	28.1	44.8	21.8	23.0
6	16.2-16.7	(CL-ML)	30.6	25.9	22.4	3.5

twin city testing corporation

CONSOLIDATION TEST CURVE

PERCENT SETTLEMENT VS. PRESSURE



PRESSURE — TONS/SQ. FT.

Project Chaska Creek Diversion

Job No. 4220 88-226

G_S=2.66

Date March 1, 1988

Boring No. 87-77M

Soil Type (ASTM: D2487) Silt (ML)

Sample No. 1

Original Moisture Content, Dry Density 23.8 % 103.0 PCF

Depth (FT.) 9.0-10.8 (Top)

Liquid Limit 26.4 % Plastic Limit 23.9 %

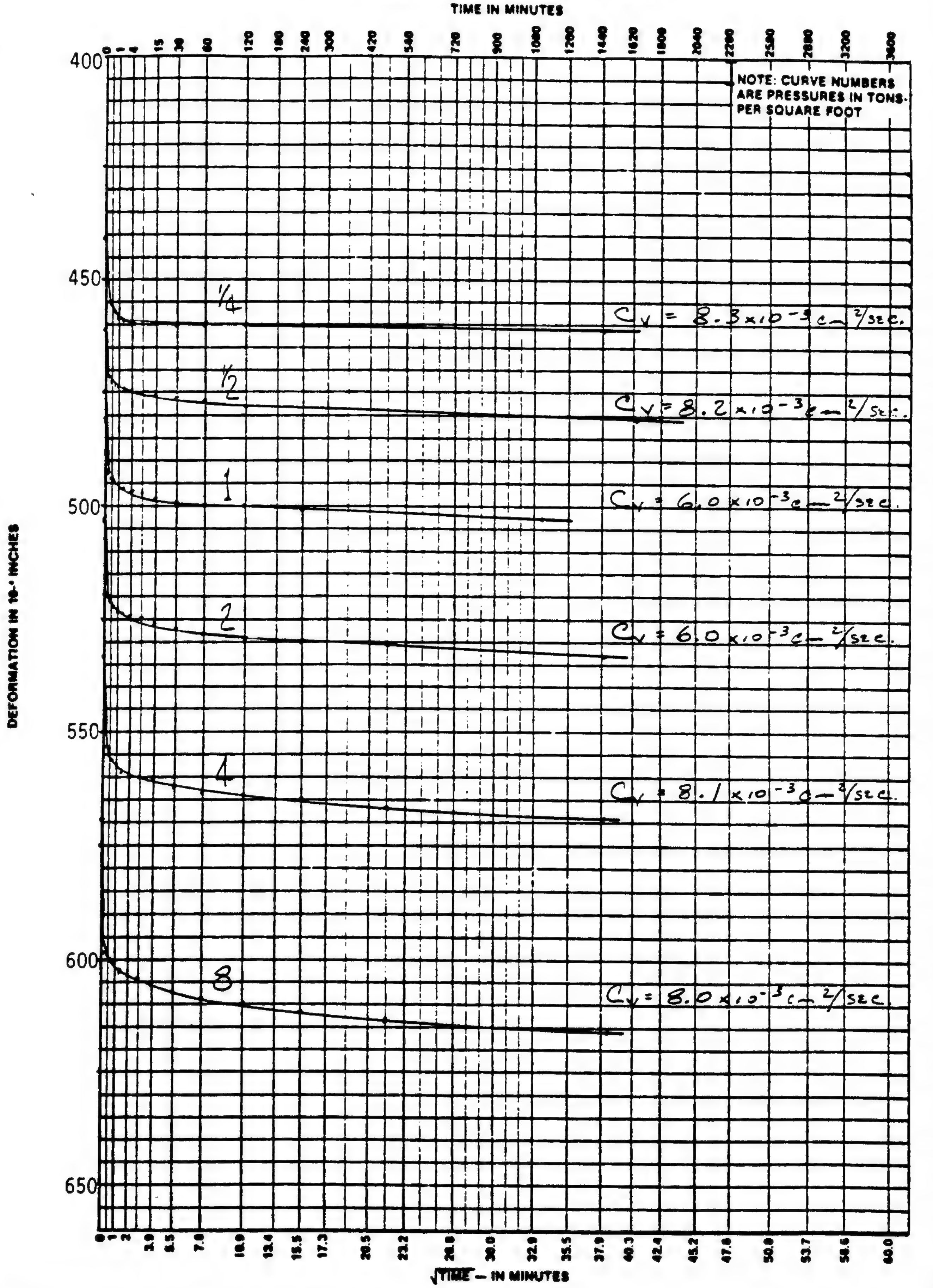
Initial Sample Height (IN.) 0.750

Preconsolidation Pressure (Pc) 2.0 tsf

Sample Diameter (IN.) 2.500

Compression & Recompression Index: C_c 0.02 C_r

CONSOLIDATION TEST TIME CURVES



PROJECT	Chaska Creek Diversion				
JOB. NO. 4220 88-226	SAMPLE NO.	1	BORING NO.	87-77M	DEPTH 9.0'-10.8' (Top)

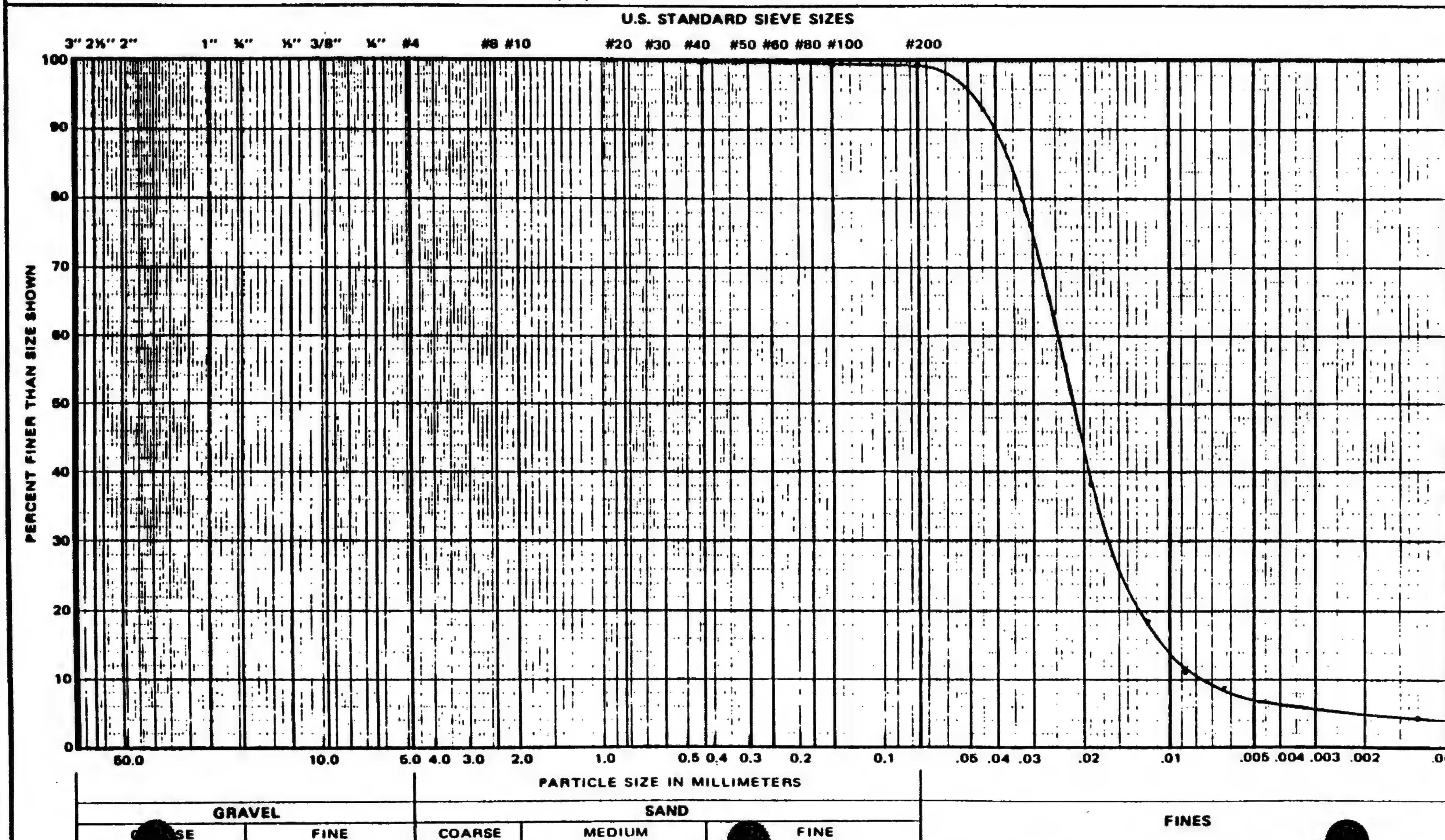
Figure C-209

GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion — DATE March 8, 1988

REPORTED TO St. Paul District Corps of Engineers — JOB NO. #4220 88-226

BORING NO. 87-77M SAMPLE NO. 1 DEPTH (FT) 9.0-10.8 SOIL TYPE Silt (ML)



662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

Figure C-210

TRIAXIAL TEST DATA

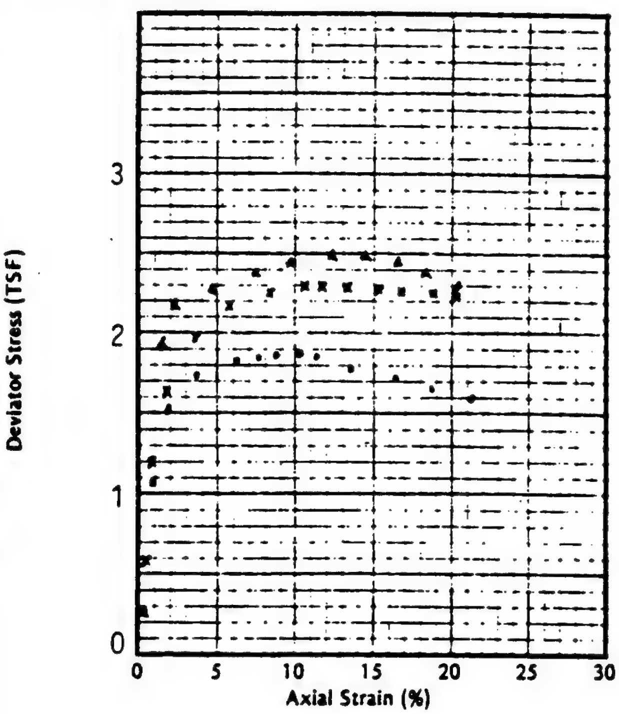
Date March 2, 1988 **Job No.** 4220 88-226

Project Chaska Creek Diversion

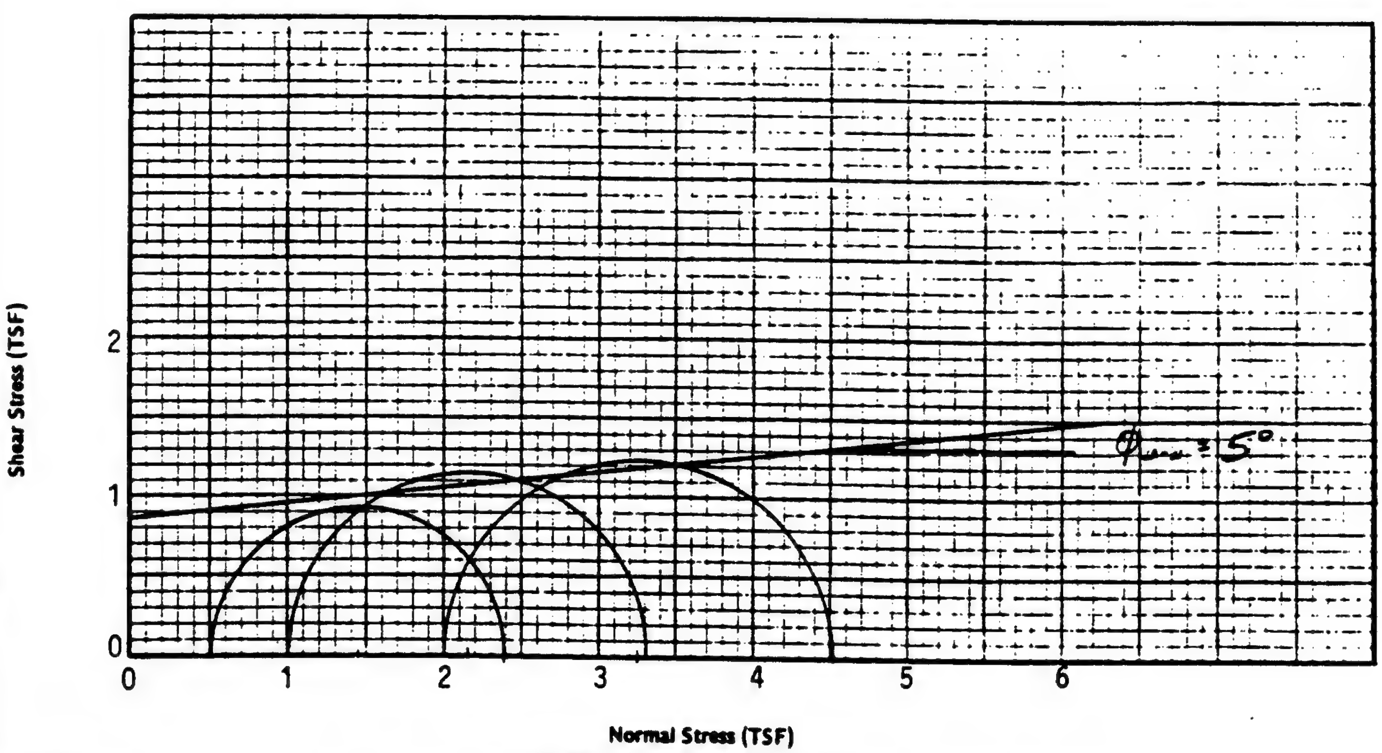
Boring No. 87-77M **Sample No.** 2 **Depth (ft)** 13.0-14.5 **Type of Sample** 5T

Soil Type Lean Clay (CL/CH) **Type of Test** U-U

Remarks: Specimens trimmed to given sizes; lucite discs placed on each end; all drainage valves closed; stressed to given strains at constant rate of 0.060"/min.; Mohr circles at maximum deviator stress.



SPECIMEN NO.		A	B	C
Initial	Diameter (inches)	1.99	2.00	2.00
	Height (inches)	4.05	4.21	4.14
	Moisture Content (%)	28.5	28.2	29.0
	Dry Density (PCF)	95.4	96.3	95.6
	Saturation (%)	100	100	100
	Void Ratio	0.77	0.75	0.76
Before Shear	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)			
	Void Ratio			
	Back Pressure (TSF)	0	0	0
Minor Principal Stress TSF (σ_3)		0.50	1.00	2.00
Maximum Deviator Stress TSF ($\sigma_1 - \sigma_3$)		1.86	2.30	2.50
Ultimate Deviator Stress TSF ($\sigma_1 - \sigma_3$)				
LL 47.7	PI 25.6			
PL 22.1	G_s 2.70			
		•	×	▲



DIRECT SHEAR TEST

PROJECT Chaska Creek Diversion

REPORTED TO St. Paul District Corps of Engineers

DATE: March 1, 1988

JOB NO. 4220 88-226

BORING NO. 87-77M SAMPLE NO. 2 DEPTH (FT.) 13.0-14.5

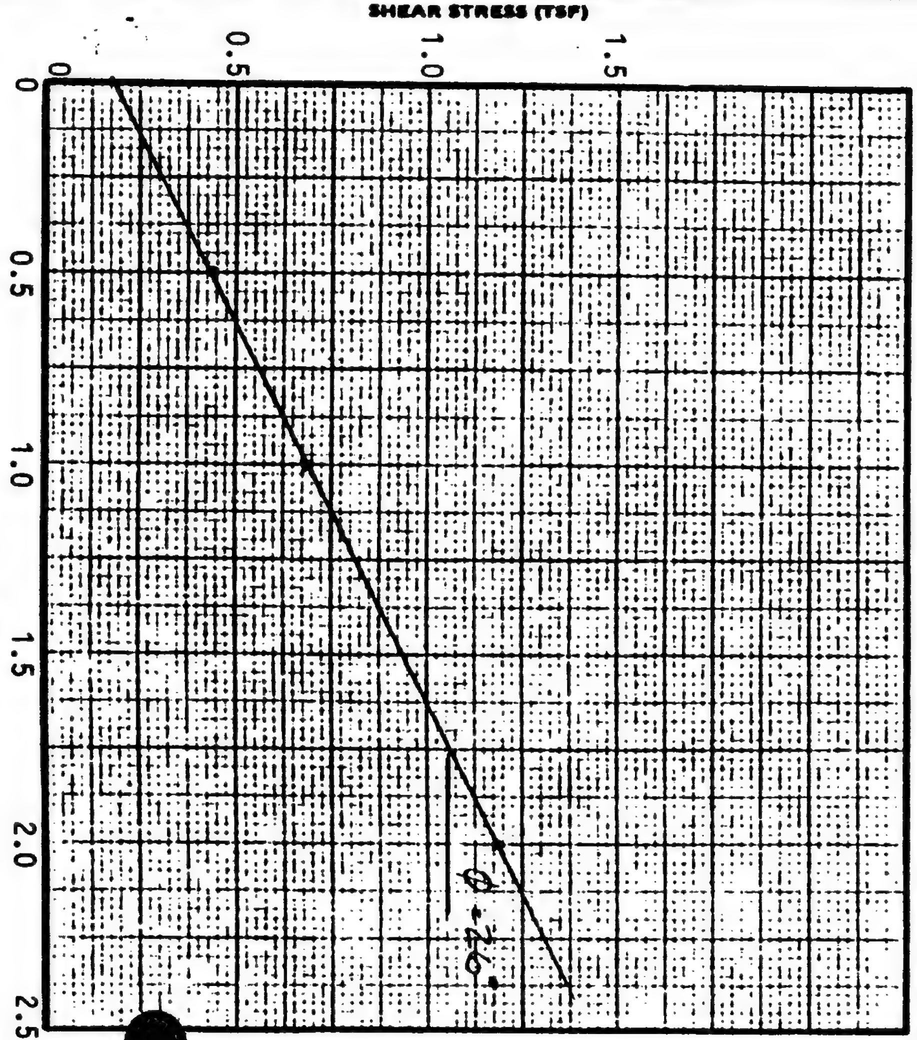
SAMPLE DIAMETER (INCHES) 2.500 SAMPLE HEIGHT (INCHES) 0.500

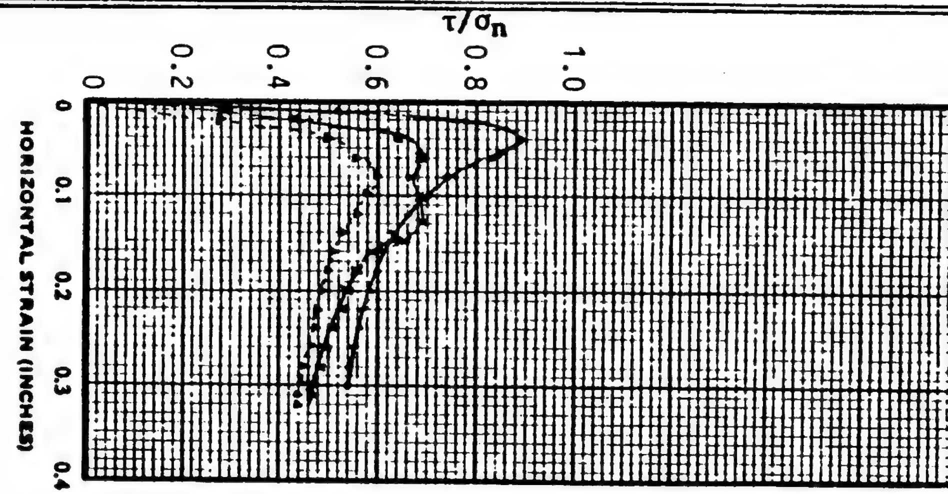
W.C. 26.6 28.4 28.1 Dry Density 99.5 96.0 101.5

LIQUID LIMIT (%) 47.7 PLASTIC LIMIT (%) 22.1 PLASTICITY INDEX 25.6

CLASSIFICATION (ASTM: D 2487) Lean Clay (CL/CH)

NOTES: Specimens trimmed to given sizes; consolidated under normal load, well into secondary compression; sheared to given strains at constant rate of 0.00064"/min.





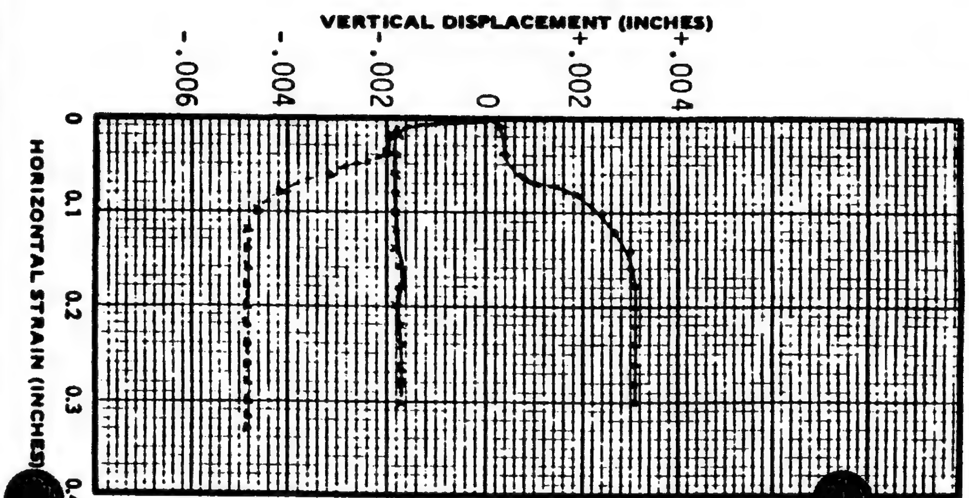
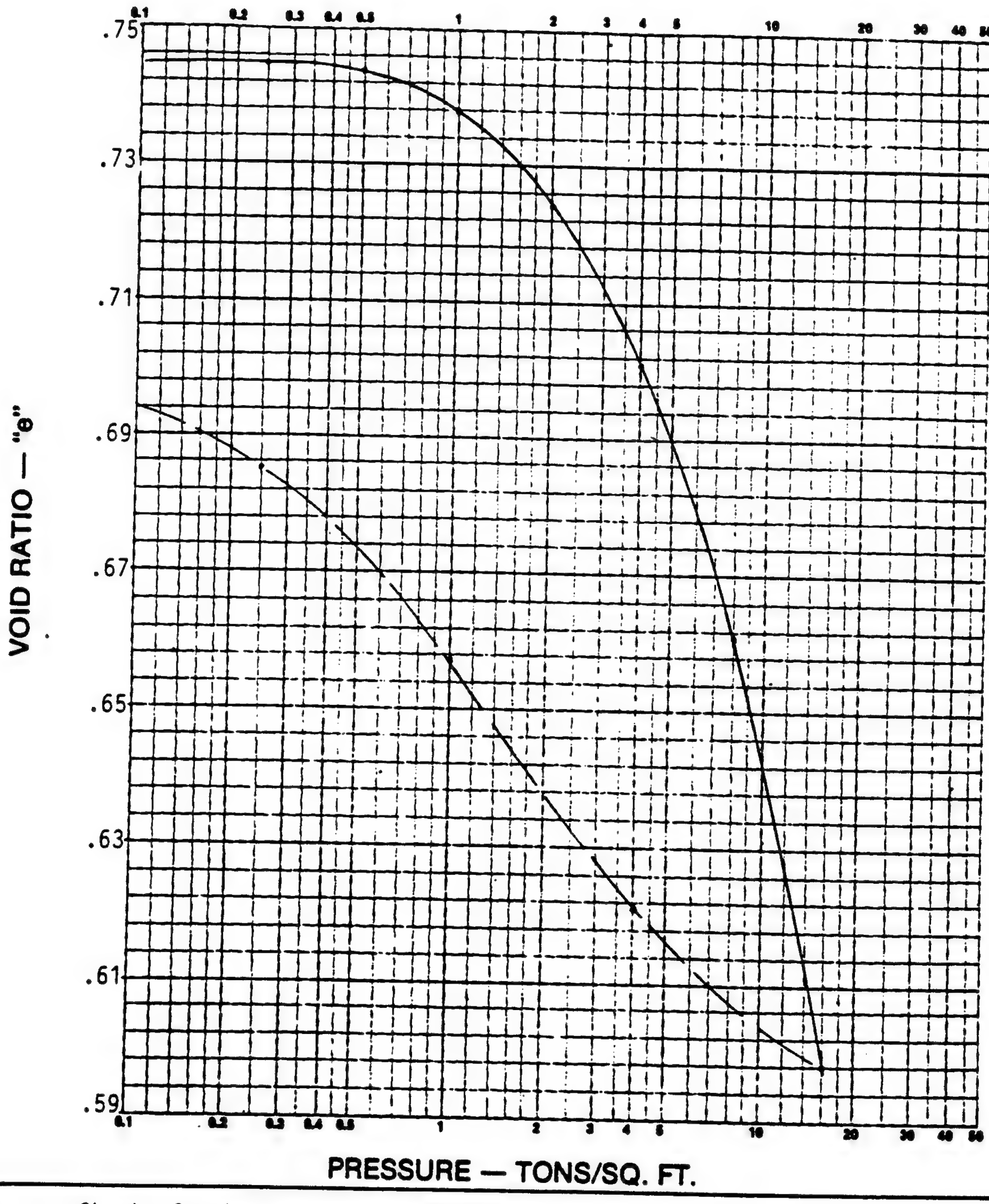


Figure C-212

CONSOLIDATION TEST CURVE

VOID RATIO VS. PRESSURE



Project: Chaska Creek Diversion

Job No. 4220 88-226

G_s=2.70

Date: March 1, 1988

Boring No. 87-77M

Soil Type (ASTM: D2487): Lean Clay (CL/CH)

Sample No. 2

Original Moisture Content, Dry Density: 28.6 % 96.7 PCF

Depth (FT.) 13.0'-14.5'(Middle)

Liquid Limit: 47.7 % Plastic Limit: 22.1 %

Initial Sample Height (IN.) 0.795

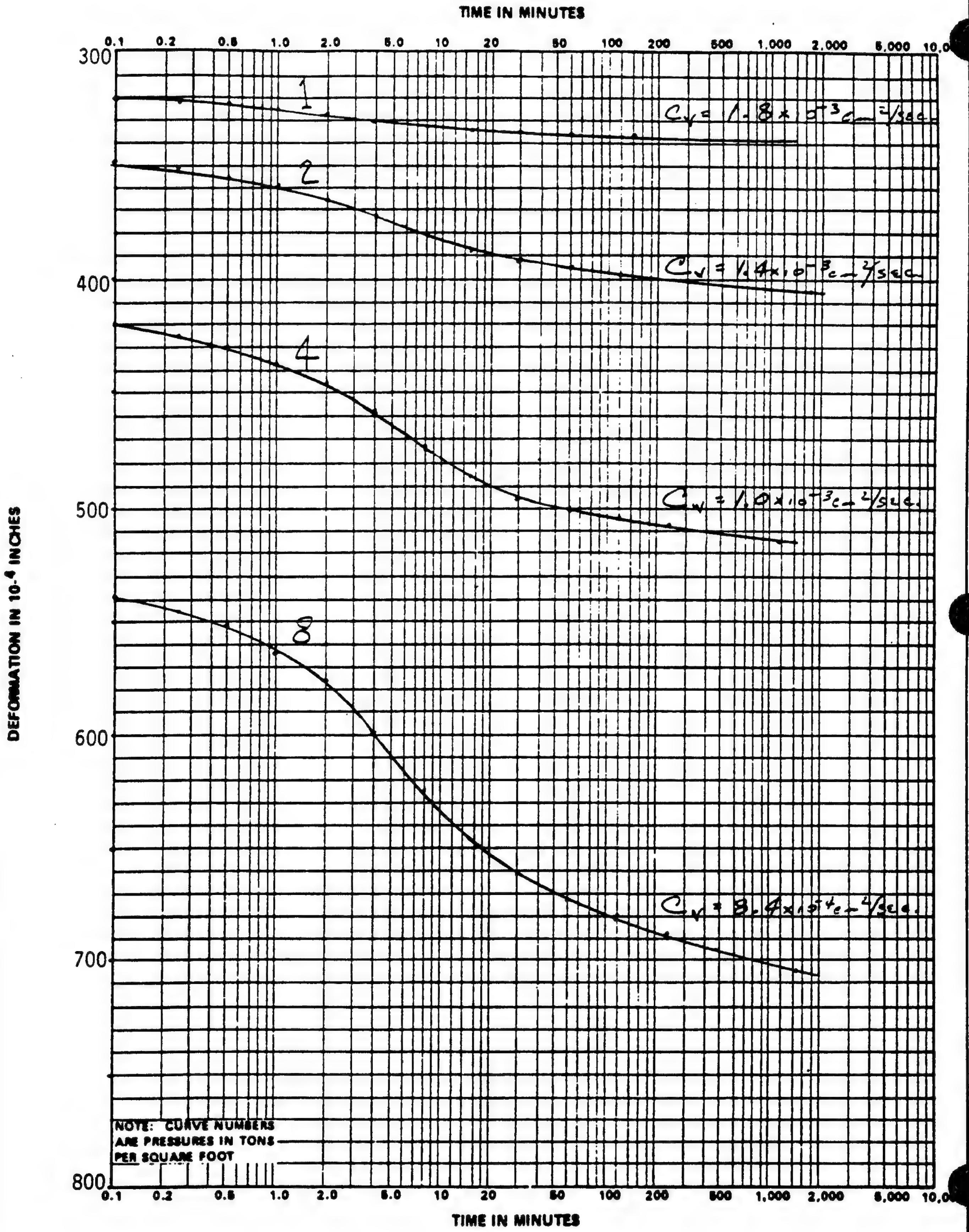
Preconsolidation Pressure (Pc): 2.2 tsf

Sample Diameter (IN.) 2.501

Compression & Recompression Index: C_c 0.14 C_r

SL-6 (77-C) 662 CROMWELL AVENUE twin city testing ST. PAUL, MN. 55114

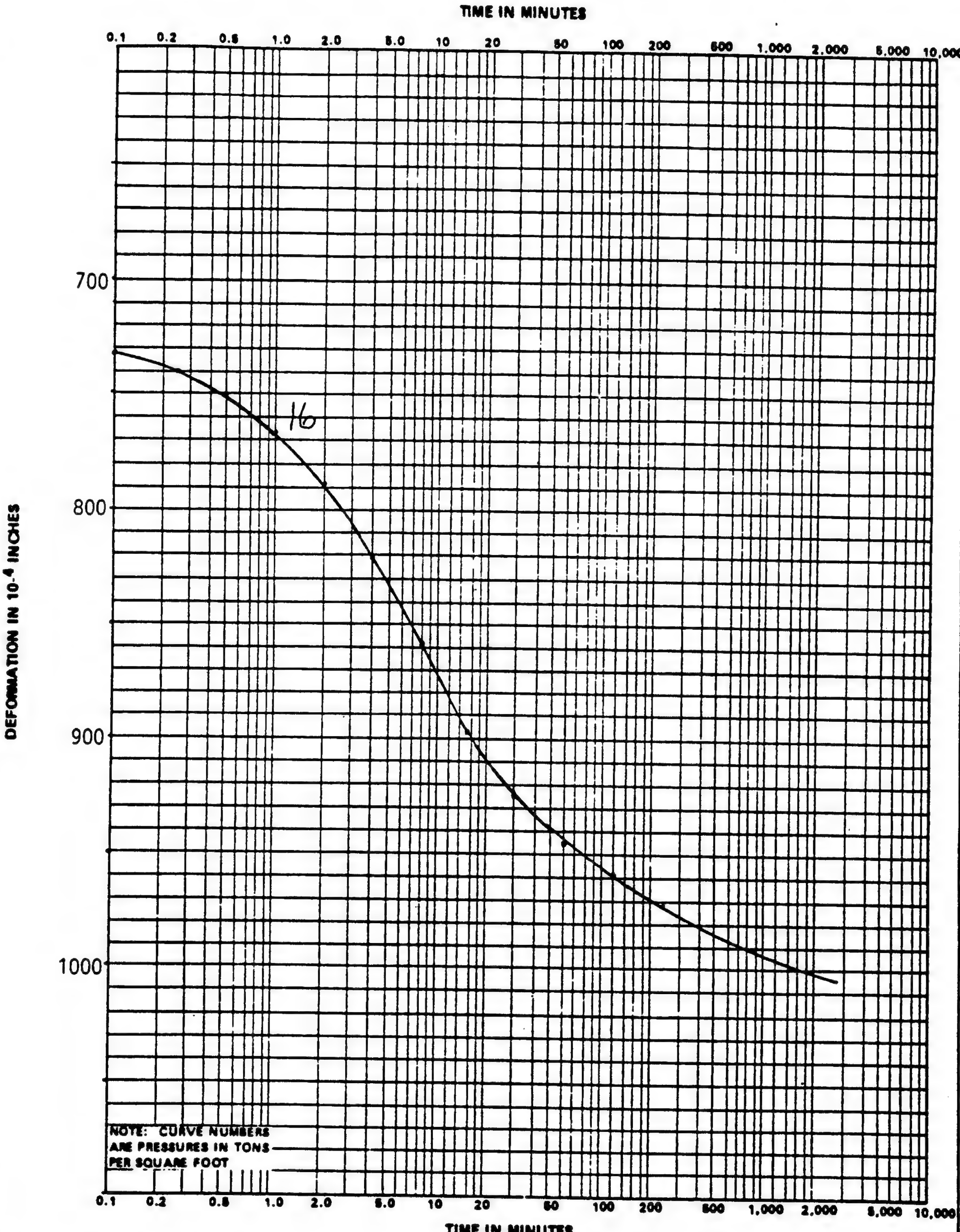
CONSOLIDATION TEST TIME CURVES



PROJECT:	Chaska Creek Diversion

JOB NO.:	4220 88-226	SAMPLE NO.:	2	BORING NO.:	87-77M	DEPTH:	13.0'-14.5'(Middle)

CONSOLIDATION TEST TIME CURVES



PROJECT: Chaska Creek Diversion

JOB NO.: 4220 88-226	SAMPLE NO.: 2	BORING NO.: 87-77M	DEPTH: 13.0'-14.5'(Middle)

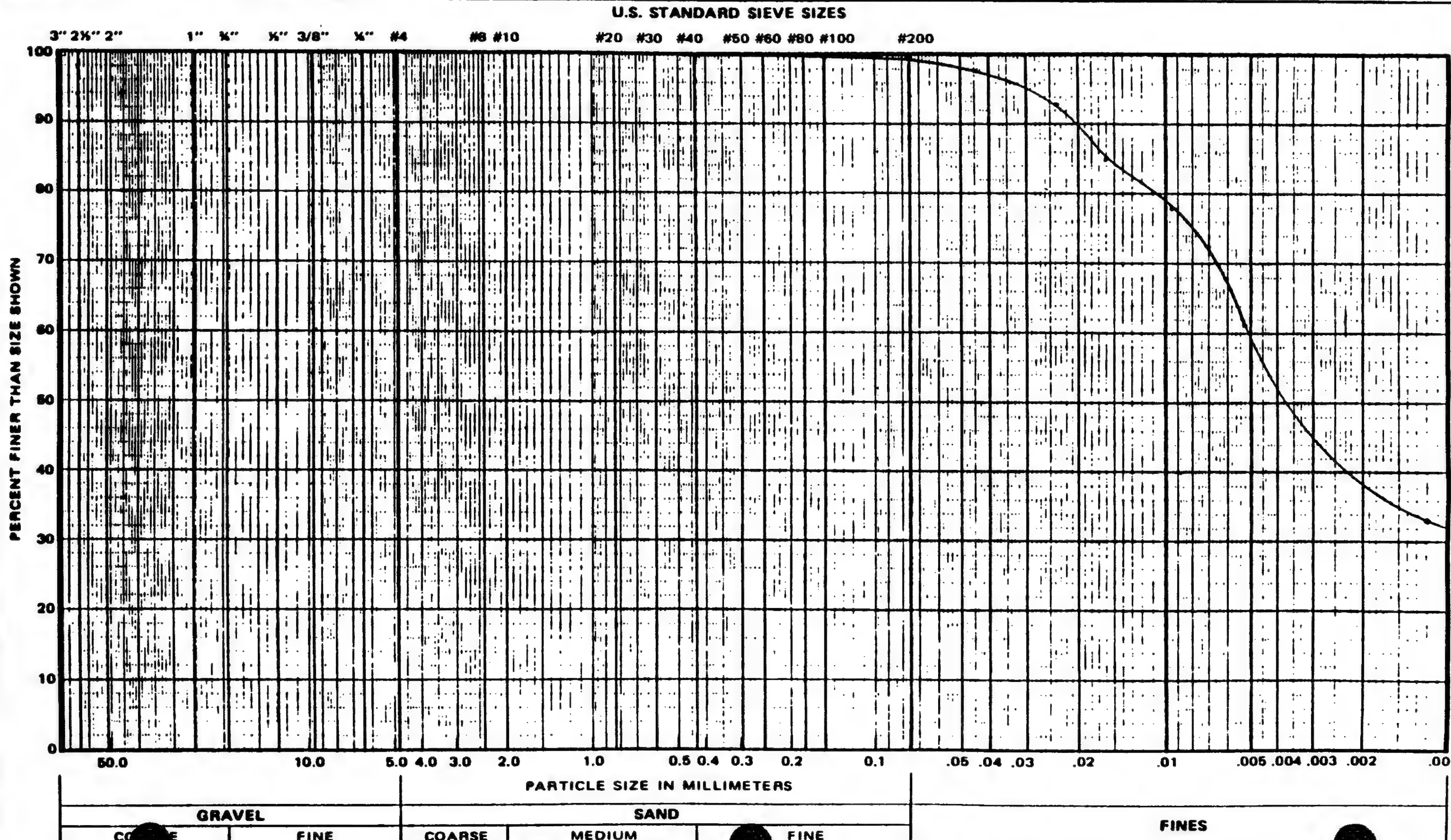
SL-17 (77-8) 662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE March 8, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-77M SAMPLE NO. 2 DEPTH (FT) 13.0-14.5 SOIL TYPE Lean Clay (CL/CH)



862 CROMWELL AVENUE twin city testing ST. PAUL, MN. 55114

DIRECT SHEAR TEST

PROJECT Chaska Creek Diversion

REPORTED TO St. Paul District Corps of Engineers

DATE: March 9, 1988

JOB NO. 4220 88-226

BORING NO. 87-77M SAMPLE NO. 3 DEPTH (FT.) 20-22

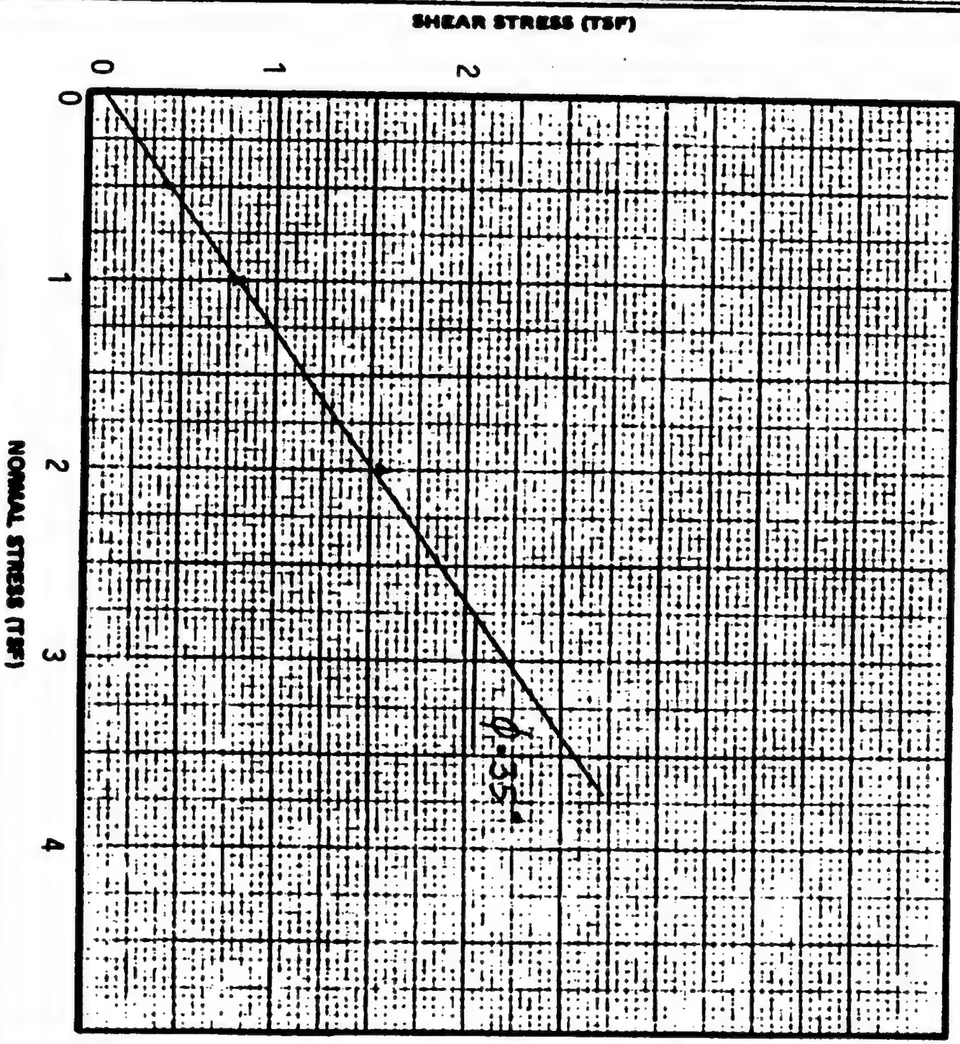
SAMPLE DIAMETER (INCHES) 2.500 SAMPLE HEIGHT (INCHES) 0.500

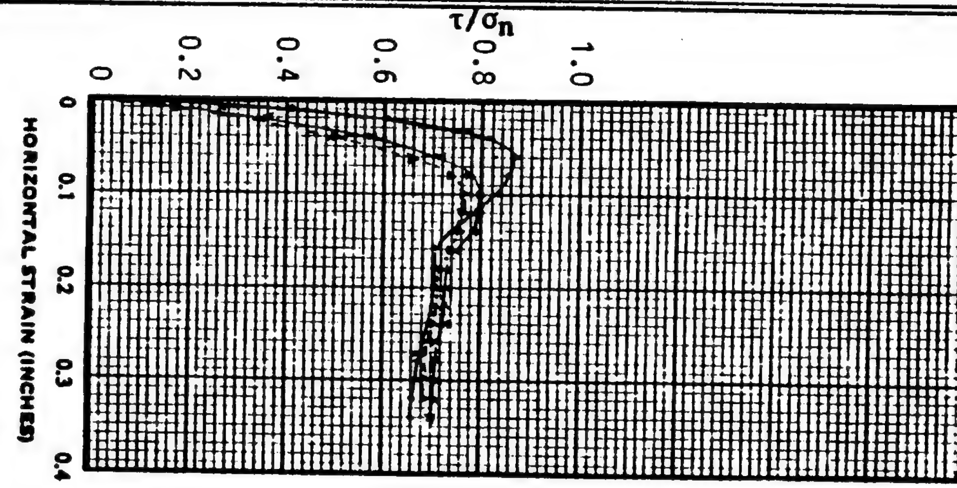
W.C. 21.1 20.4 21.6 Dry Density 109.0 110.7 109.0

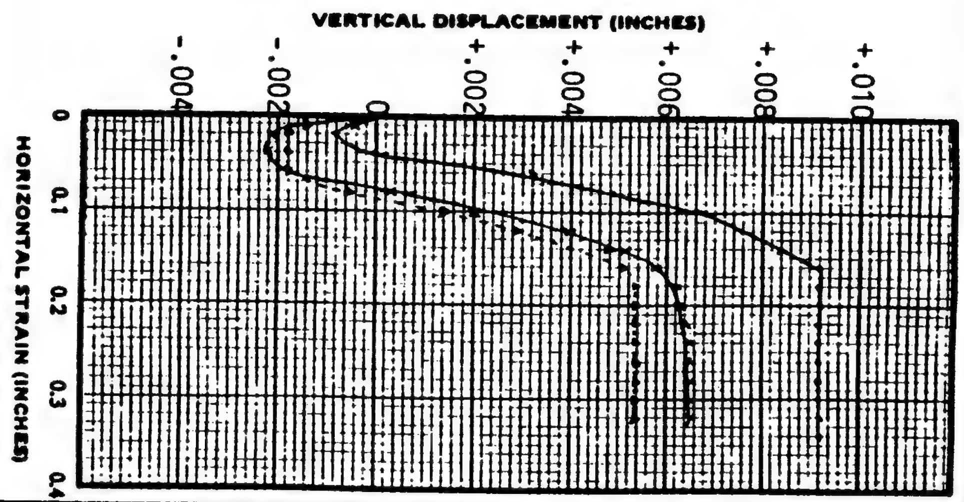
LIQUID LIMIT (%) 23.2 PLASTIC LIMIT (%) 23.3 PLASTICITY INDEX NP

CLASSIFICATION (ASTM: D 2487) SILT (ML)

NOTES: Specimens trimmed to given sizes; consolidated under normal load, well into secondary compression; sheared to given strains at constant rate of 0.00096"/min.



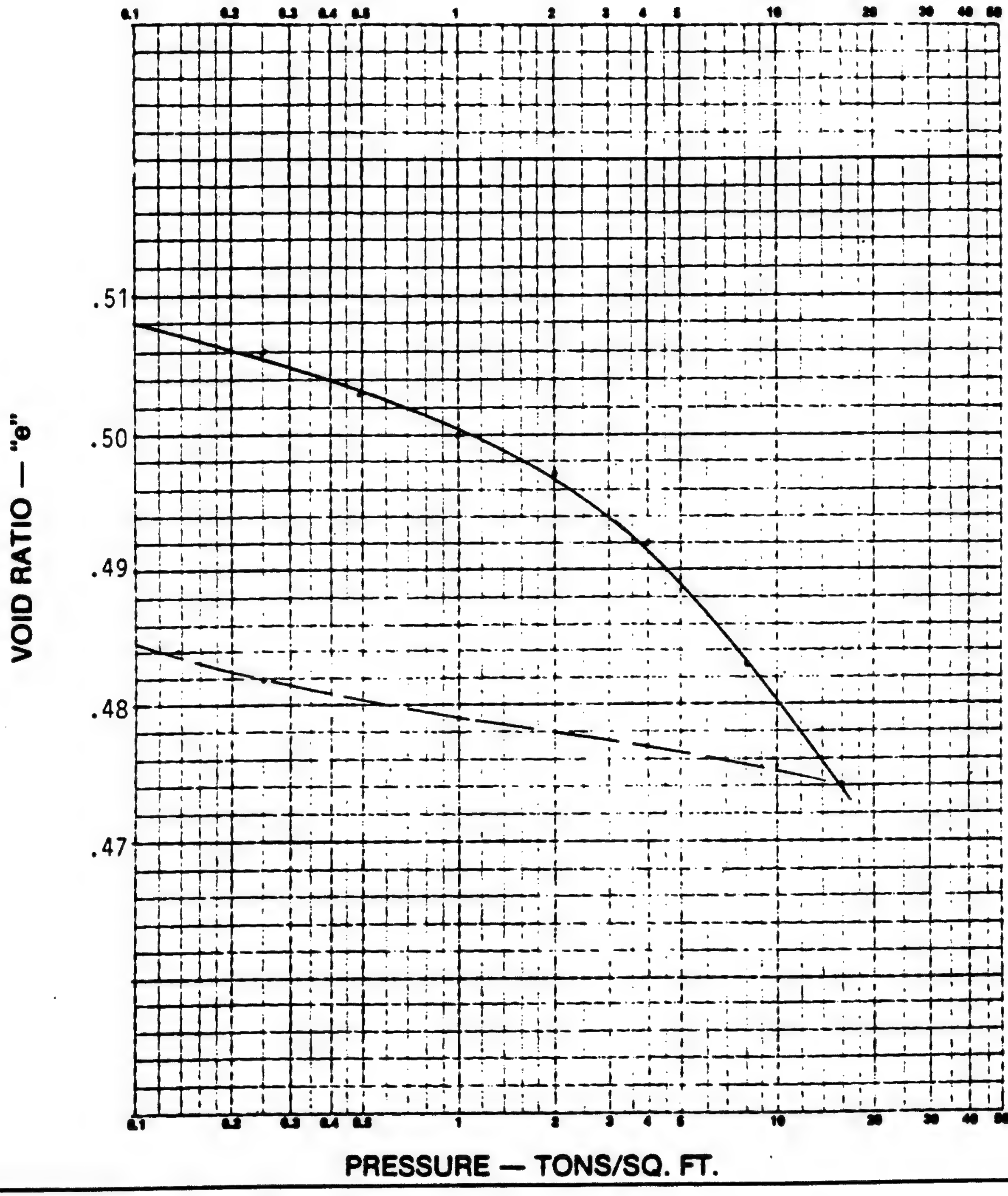




662 CROMWELL AVENUE twin city testing corporation ST PAUL, MN 55114

CONSOLIDATION TEST CURVE

VOID RATIO VS. PRESSURE



Project: Chaska Creek Diversion

Job No. 4220 88-226 G_S=2.67 Date: March 1, 1988

Boring No. 87-77M Soil Type (ASTM: D2487): Silt (ML)

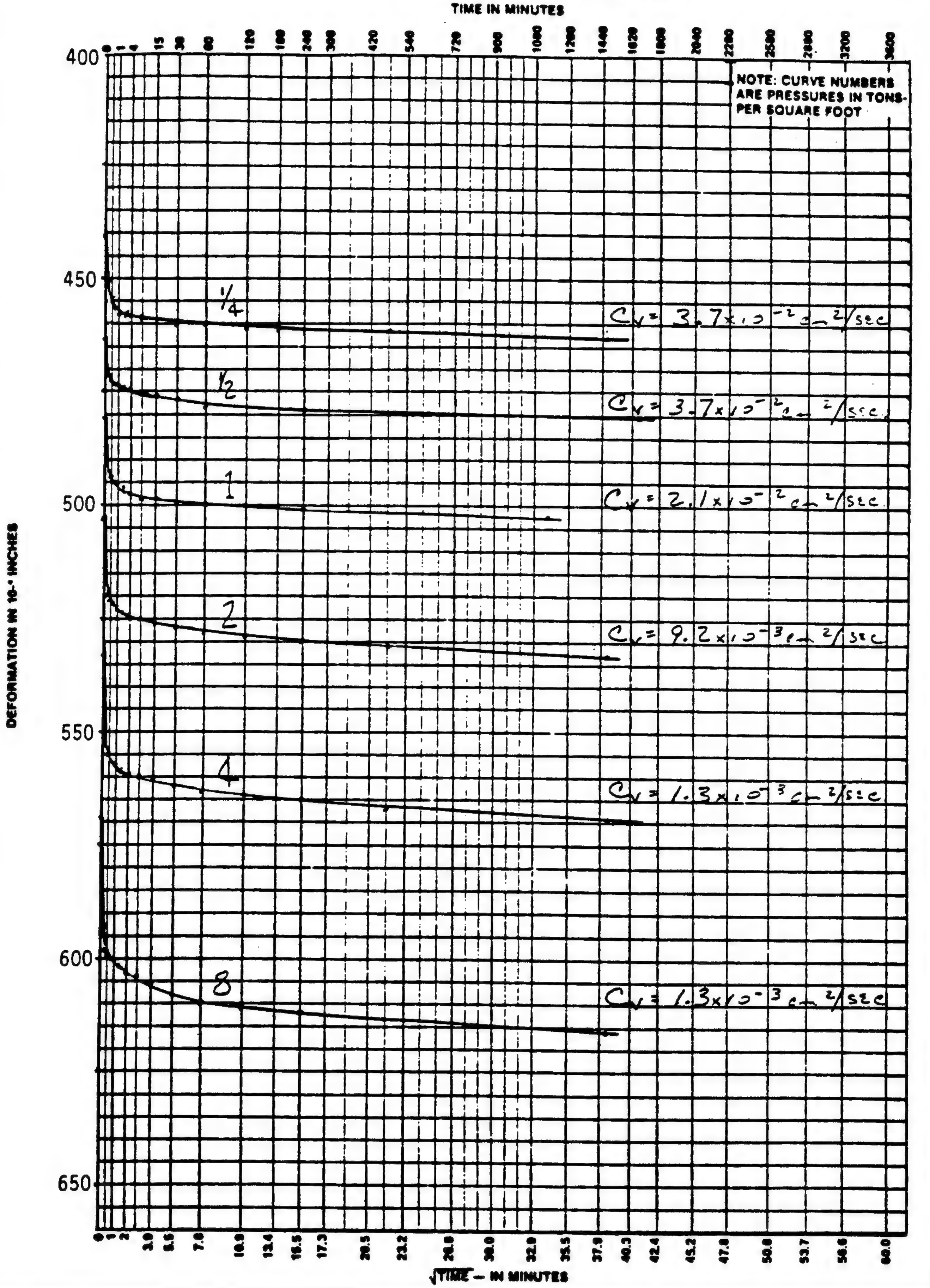
Sample No. 3 Original Moisture Content, Dry Density: 20.0 % 110.0 PCF

Depth (FT.): 20-22 (Middle) Liquid Limit: 23.2 % Plastic Limit: 23.3 %

Initial Sample Height (IN.): .796 Preconsolidation Pressure (Pc): 3.3 tsf

Sample Diameter (IN.): 2.501 Compression & Recompression Index: C_c 0.03 C_r

CONSOLIDATION TEST TIME CURVES



PROJECT Chaska Creek Diversion			
JOB. NO. 4220 88-226	SAMPLE NO. 3	BORING NO. 87-77M	DEPTH 20.0'-22.0'(Middle)

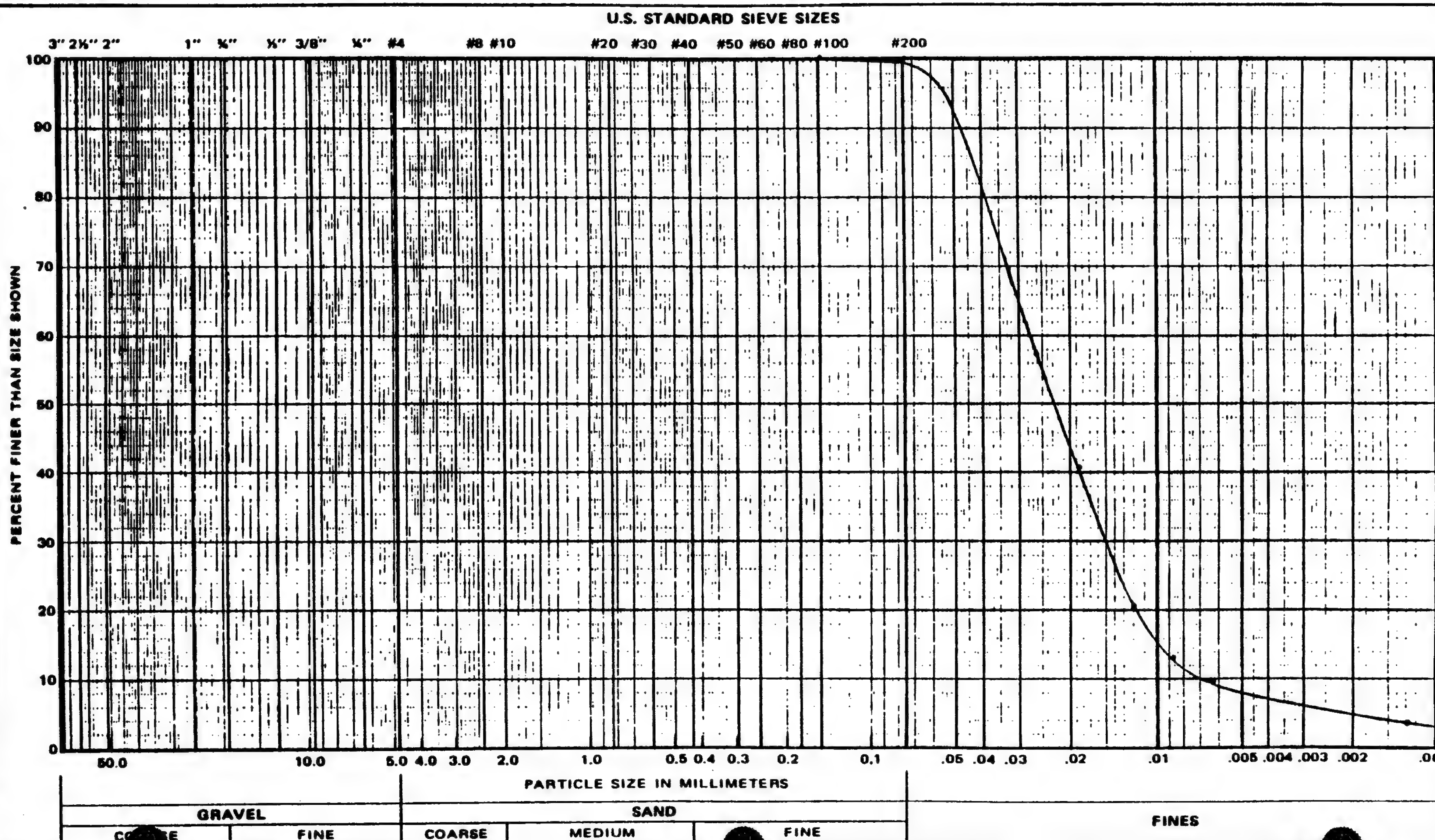
662 CROMWELL AVENUE twin city testing ST. PAUL, MN. 55114

GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE March 8, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-77M SAMPLE NO. 3 DEPTH (FT) 20-22 SOIL TYPE Silt (ML)



662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

SL-21 (77-8)

Figure C-220

GRAIN SIZE DISTRIBUTION CURVE

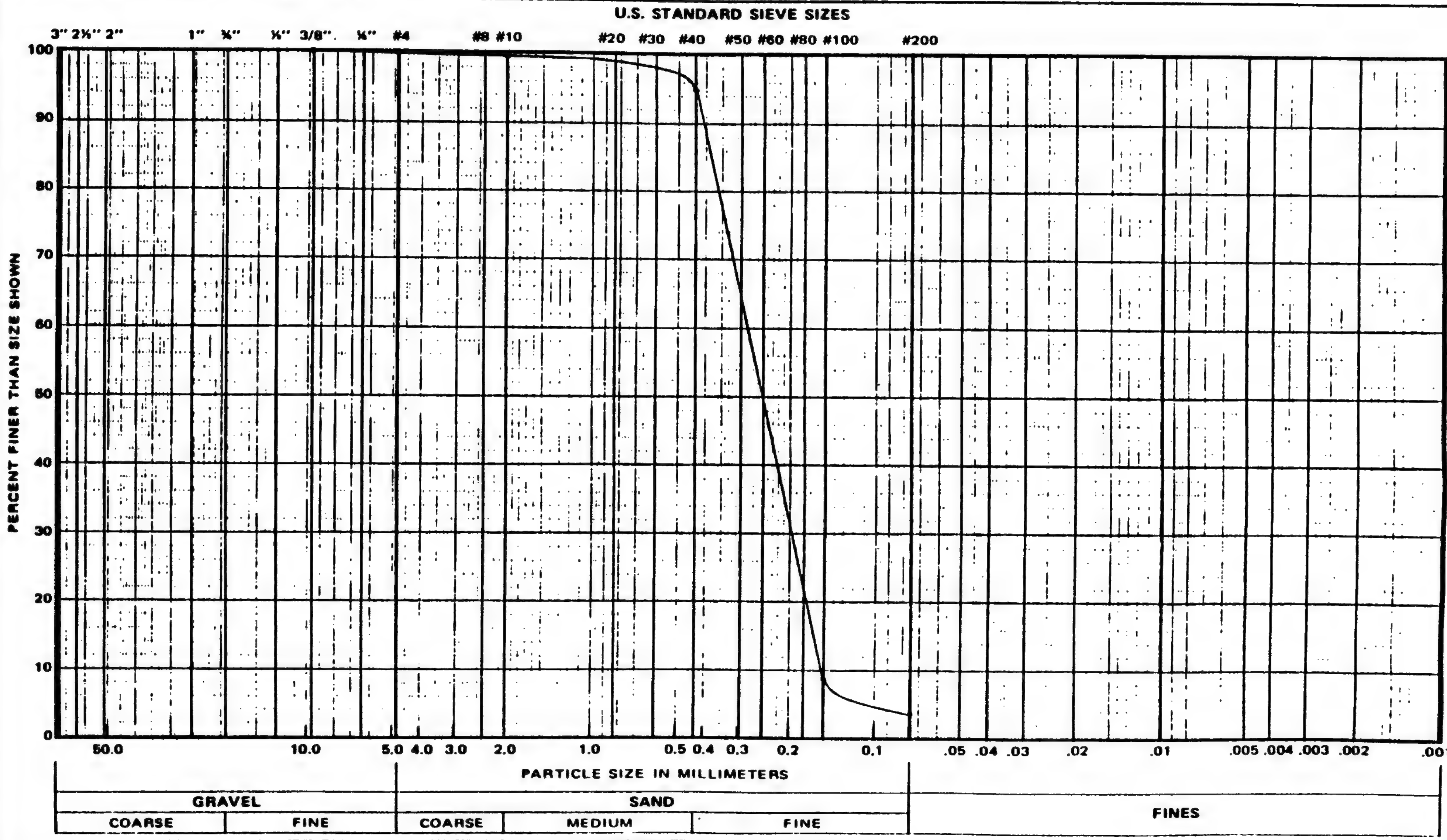
PROJECT Chaska Creek Diversion

DATE February 6, 1988

REPORTED TO St. Paul District Corps of Engineers

JOB NO. #4220 88-226

BORING NO. 87-77M SAMPLE NO. 10 DEPTH (FT) 25.2-25.7 SOIL TYPE Sand, Fine Grained (SP)



662 CROMWELL AVENUE twin city testing corporation ST. PAUL, MN. 55114

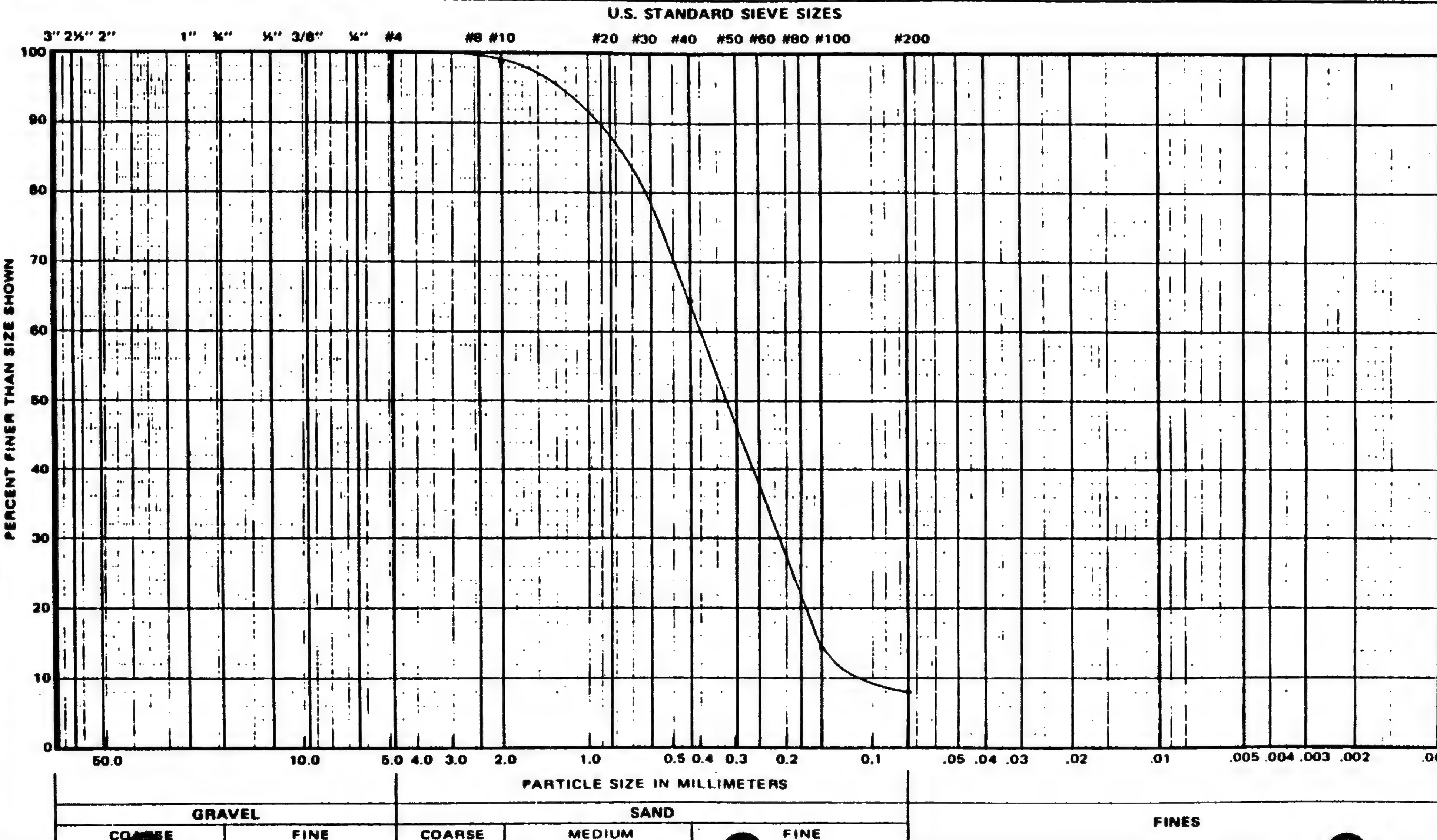
SL-21 (77-8)

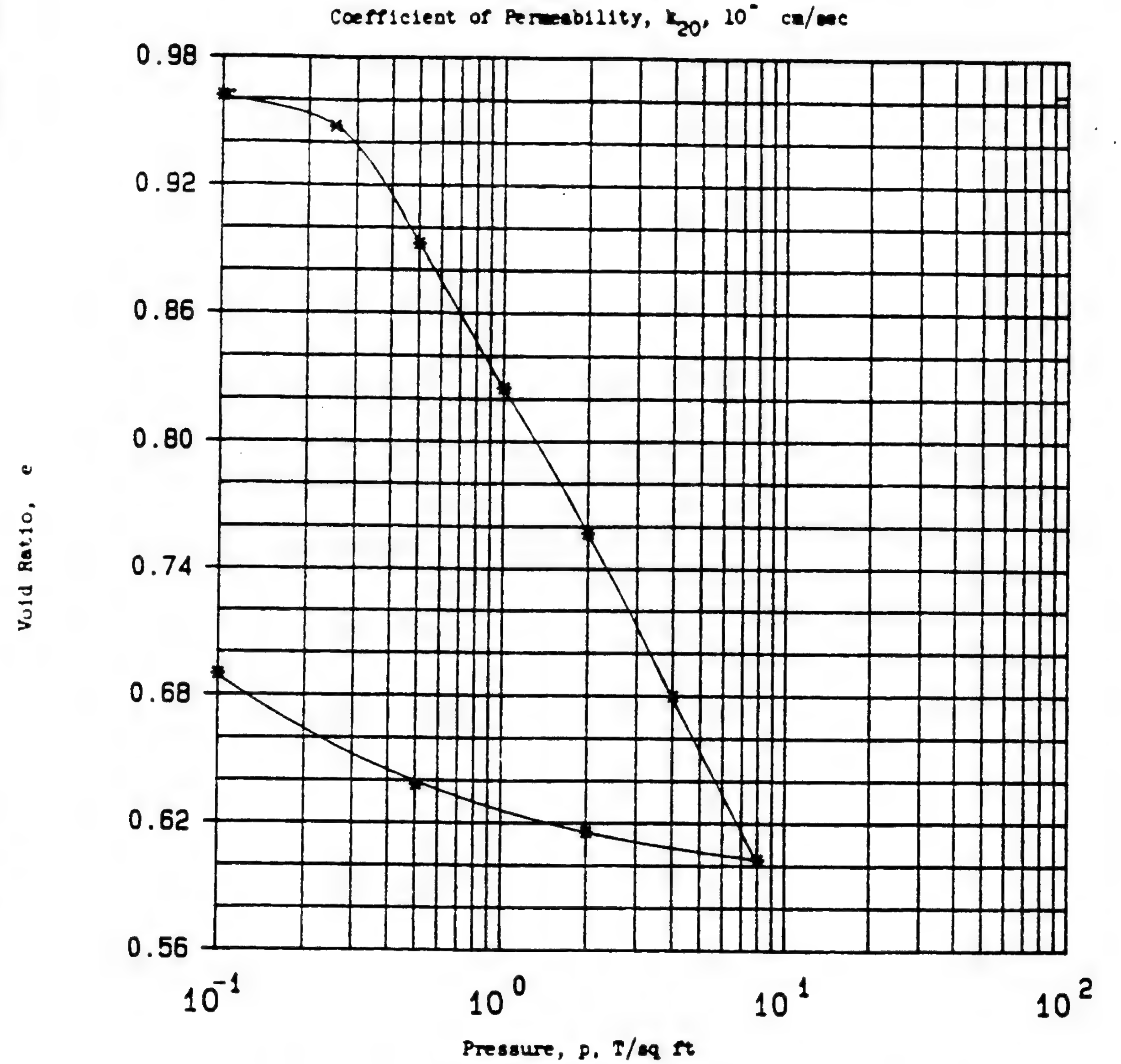
GRAIN SIZE DISTRIBUTION CURVE

PROJECT Chaska Creek Diversion DATE February 6, 1988

REPORTED TO St. Paul District Corps of Engineers JOB NO. #4220 88-226

BORING NO. 87-77M SAMPLE NO. 12 DEPTH (FT) 38.2-38.9 SOIL TYPE Sand W/Silt, Fine to Medium Grained (SP-SM)



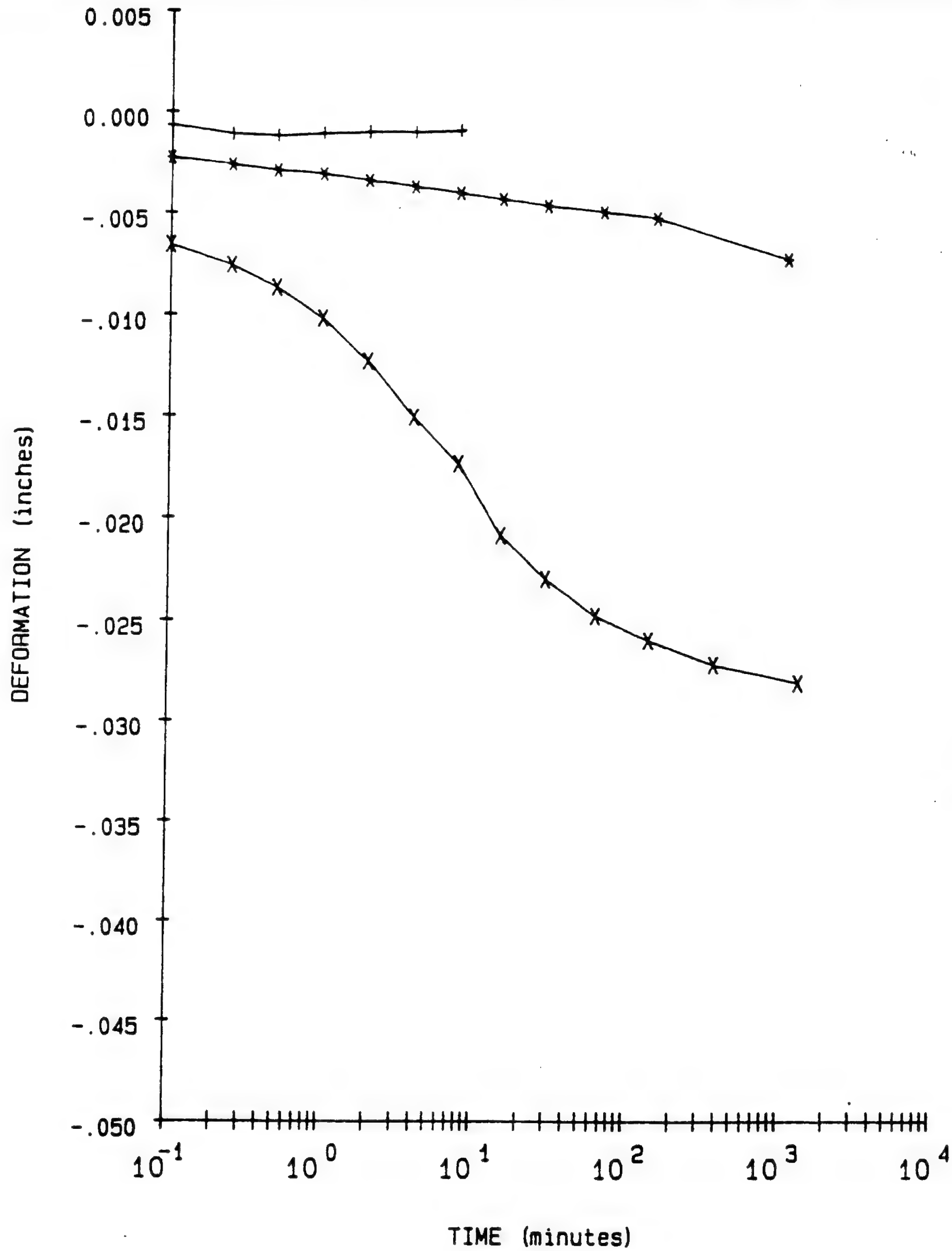


Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.4 in.	Ht 1 in.	Water Content, w_o	35.7 %	w_f	24.9 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	0.96	e_f	0.69
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	100 %	S_f	98 %
Compression Index, C_c		Dry Density, γ_d	85.8 lb/ft^3		
Classification Sandy clay, CH		k_{20} at e_o = x 10^{-} cm/sec			

LL 50	G_s 2.7	Project	CHASKA; NCS-IA-89-09-ED-GH
PL 19	D_{10}		
Remarks Brown gray, non-calcareous		Area	MRD LAB NO. 89/177
Torvane=0.3 TSF.		Boring No. 88-102 MU	Sample No. 1
		Depth El 4'-6'	Date
		CONSOLIDATION TEST REPORT	

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 9



LEGEND

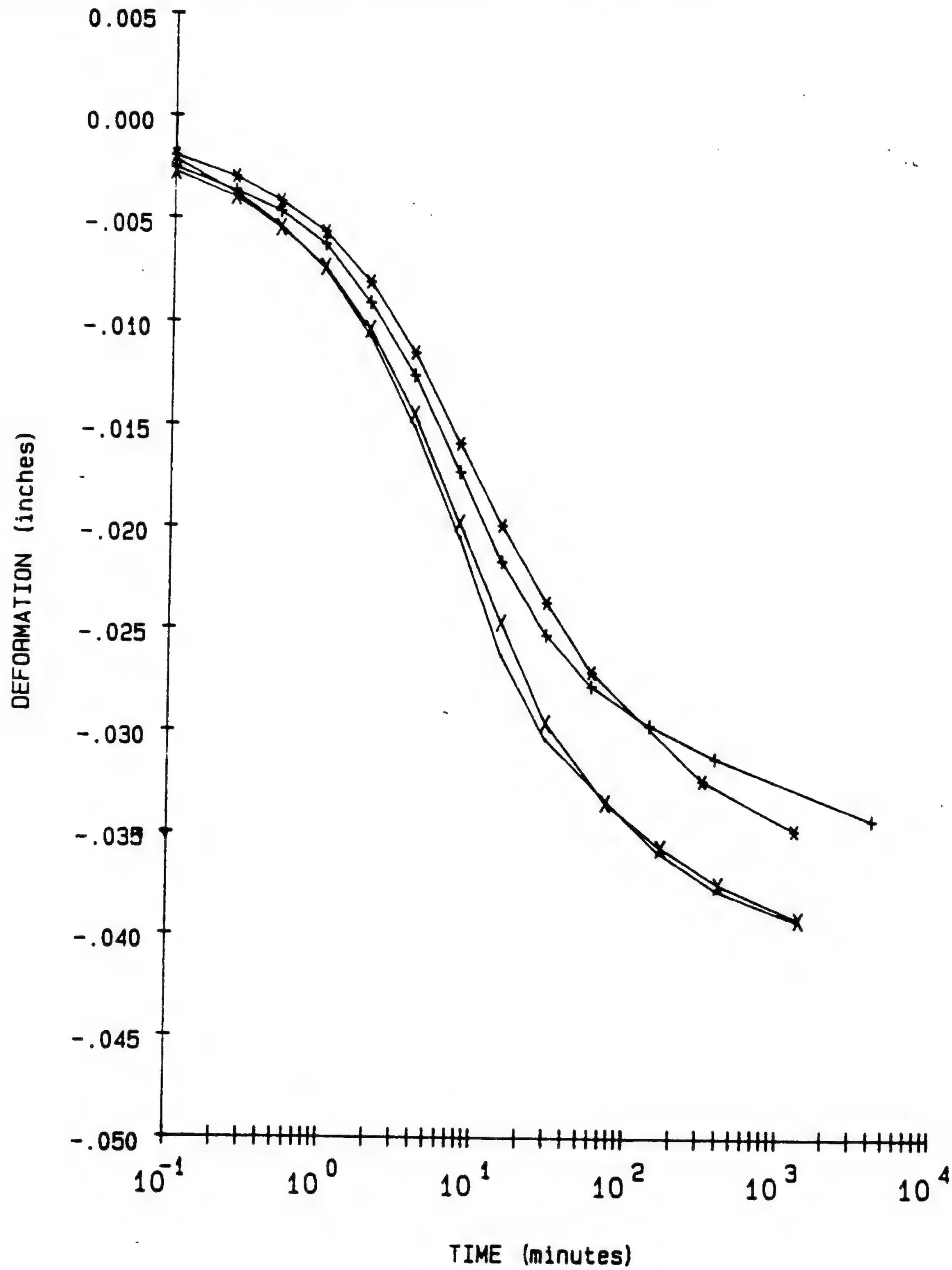
+ = .1 TSF

* = .25 TSF

X = .5 TSF

PROJECT	CHASKA: NCS-IA-89-09-ED-GH
BORING NO.	88-102 MU
SAMPLE NO.	1
DEPTH/ELEV	4'-6'
MRD LAB NO.	89/177

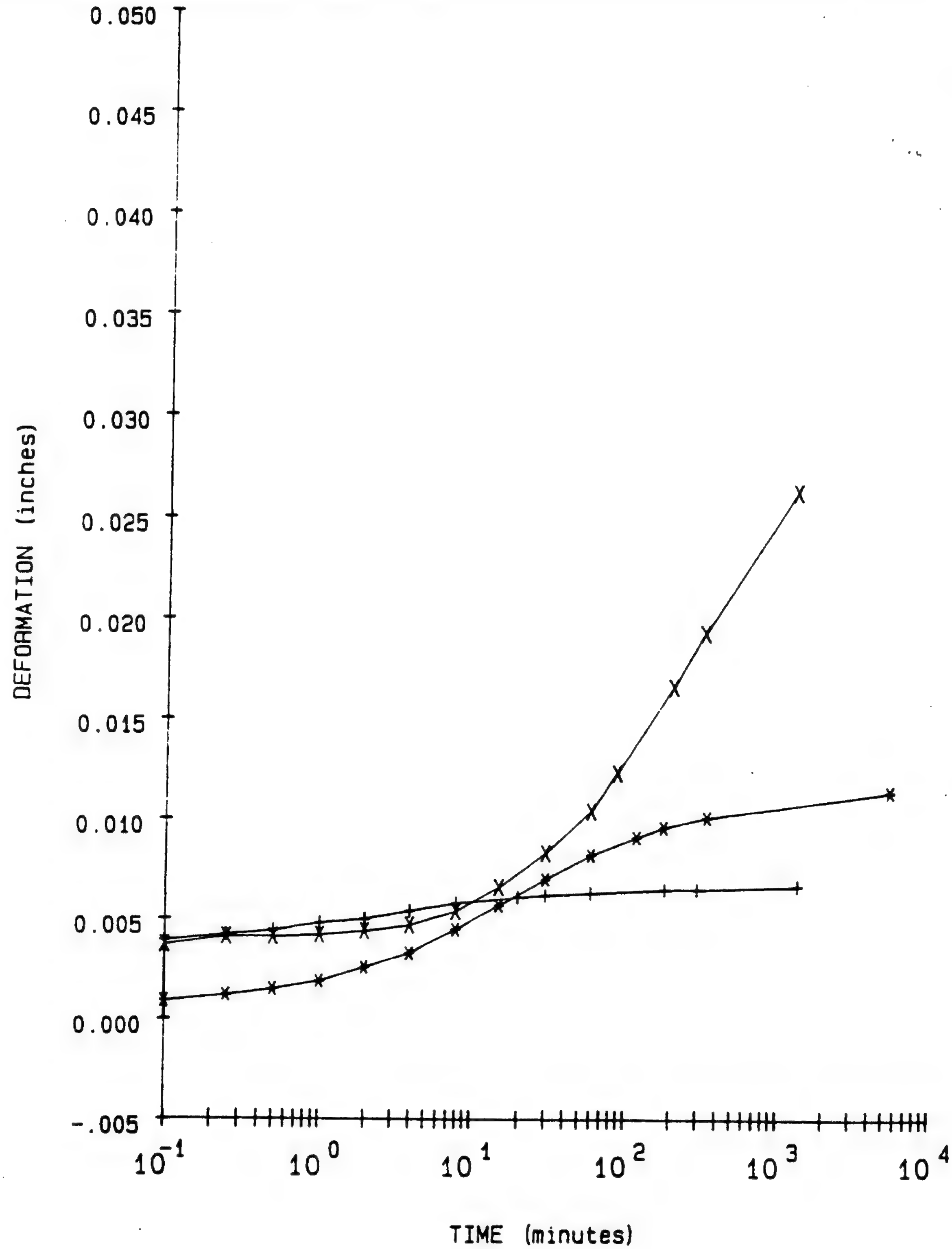
FIGURE 10



LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	CHASKA: NCS-IA-89-09-ED-6H
BORING NO.	88-102 MU
SAMPLE NO.	1
DEPTH/ELEV	4'-6'
MRO LAB NO.	89/177

FIGURE 11

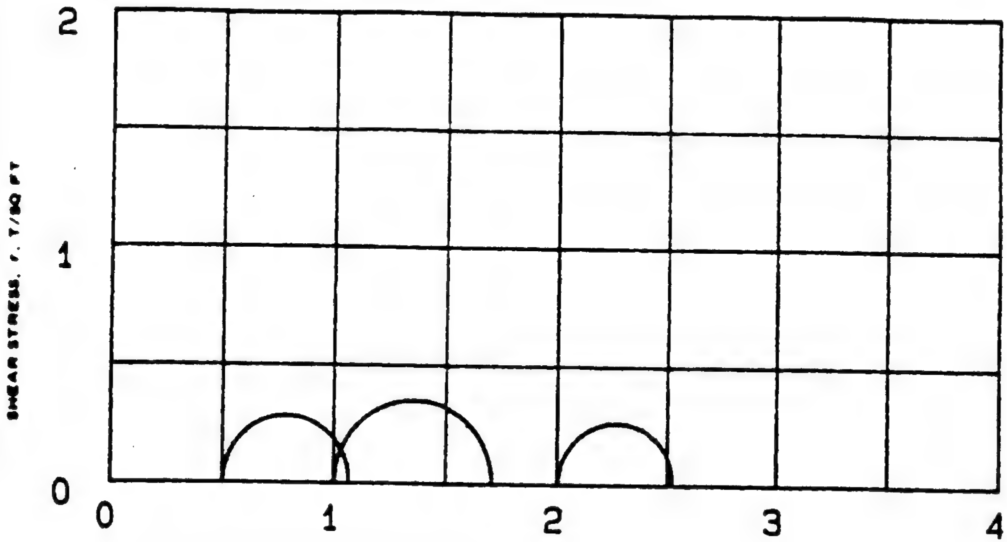


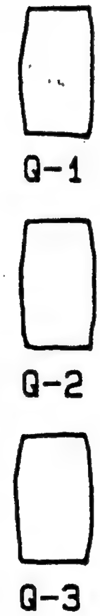
LEGEND

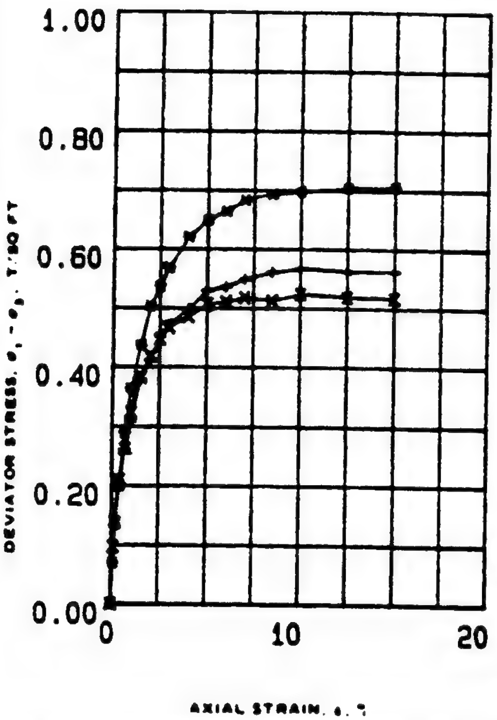
+ = 2 TSF Rebound
* = .5 TSF Rebound
X = 1 TSF Rebound

PROJECT	CHASKA: NCS-IA-89-09-ED-GH
BORING NO.	88-102 MU
SAMPLE NO.	1
DEPTH/ELEV	4'-6'
MRD LAB NO.	89/177

FIGURE 12





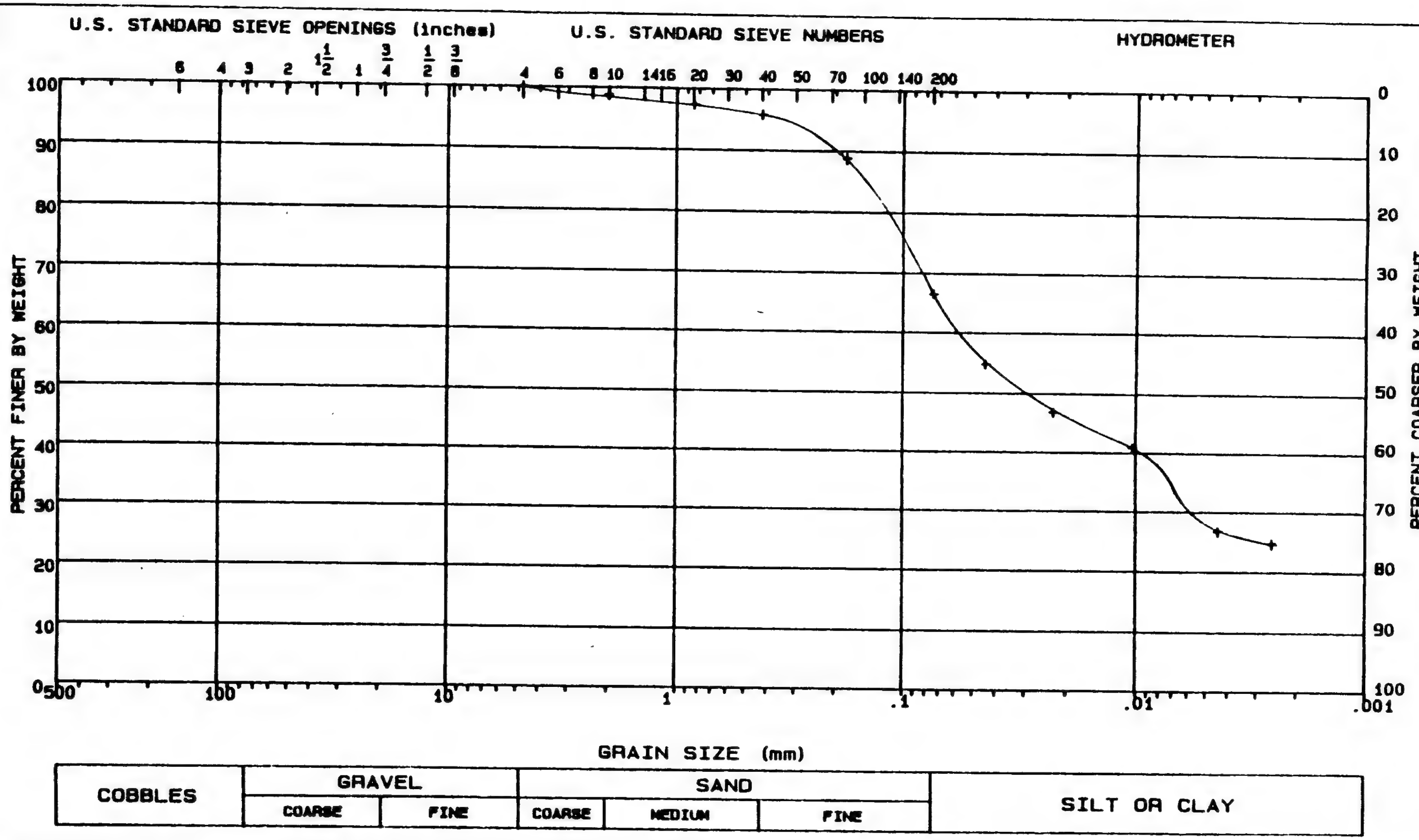


SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	31.9	33.3	36.1	
	DRY DENSITY LB/CU FT	γ_{d_o}	87.8	86.0	84.6	
	SATURATION, %	S_o	93.0	94.0	96.0	
	VOID RATIO	e_o	0.92	0.96	0.99	
BEFORE SHEAR	WATER CONTENT, %	w_c	31.8	33.1	35.0	
	DRY DENSITY LB/CU FT	γ_{d_c}	87.8	86.0	84.8	
	SATURATION, %	S_c	93.0	93.0	96.0	
	VOID RATIO	e_c	0.92	0.96	0.99	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.57	0.71	0.52	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	18.5	29.3	19.5	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.56	0.71	0.52	
INITIAL DIAMETER, IN		D_o	1.39	1.39	1.40	
INITIAL HEIGHT, IN		H_o	2.99	2.98	2.98	

CONTROLLED- STRAIN TEST					
DESCRIPTION OF SPECIMENS Sandy clay, CH					
LL 50	PL 19	PI 31	Gs 2.7Act.	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q
REMARKS: Brown gray, non-calcareous.				PROJECT CHASKA; NCS-IA-89-09-ED-GH	
Torvane=0.3 TSF.					
				BORING NO 89-102 MU	SAMPLE NO. 1
				DEPTH ELEV 4'-6'	
				LABORATORY 89/177	DATE
				TRIAXIAL COMPRESSION TEST REPORT	

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 13
REV JUNE 1970

Figure C-227



LL = 50	PL = 19	PI = 31	Gs = 2.7	NAT w = %

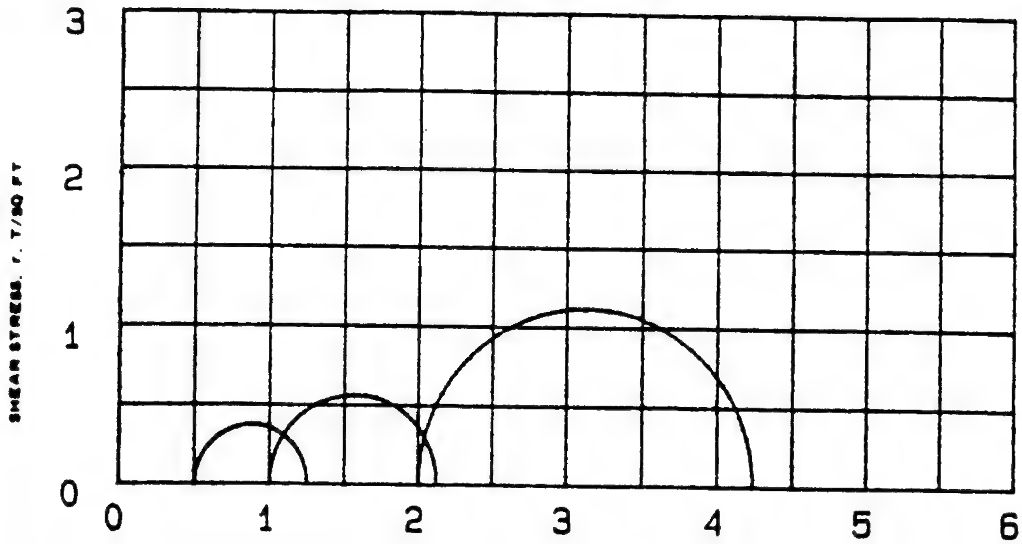
CLASSIFICATION Sandy clay, CH
Classification tests run on trimmings from Q Test

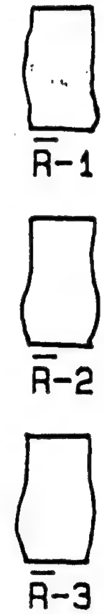
GRADATION CURVE

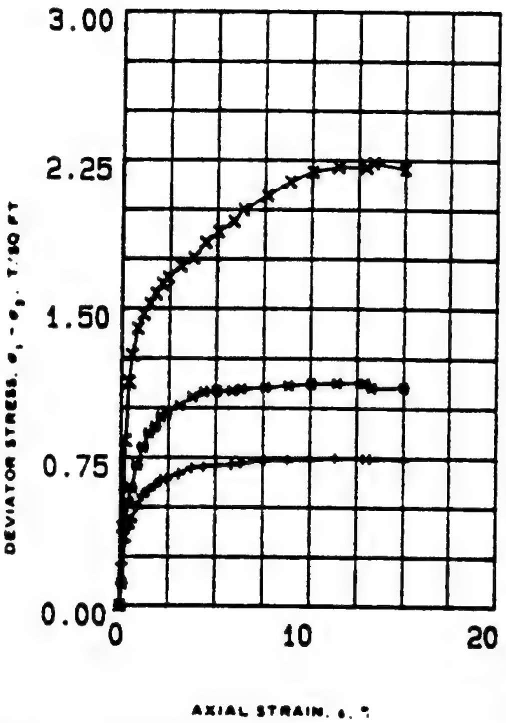
PROJECT	CHASKA; NCS-IA-89-09-ED-GH
BORING NO.	88-102 MU
SAMPLE NO.	1
DEPTH/ELEV	4'-6'
MRD LAB NO.	89/177

FIGURE 14

Figure C-228







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	39.4	40.1	35.9	
	DRY DENSITY LB/CU FT	γd_o	81.9	80.6	85.9	
	SATURATION, %	S_o	100	99	100	
	VOID RATIO	e_o	1.08	1.09	.96	
BEFORE SHEAR	WATER CONTENT, %	w_c	36.8	32.9	26.8	
	DRY DENSITY LB/CU FT	γd_c	83.3	83.5	87.9	
	SATURATION %	S_c	96	87	79	
	VOID RATIO	e_c	1.02	1.02	.92	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.823	4.823	3.3818	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.751	1.128	2.237	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1080	1080	1320	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.744	1.107	2.208	
INITIAL DIAMETER IN.		D_o	1.4	1.4	1.39	
INITIAL HEIGHT, IN		H_o	2.98	2.98	2.97	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CH

LL 50	PL 19	PI 31	Gs 2.7	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS Brown gray, non-calcareous.
Torvane=0.3 TSF.

PROJECT CHASKA: NCS-IA-89-09-ED-6H

BORING NO 88-102 MU — SAMPLE NO. 1

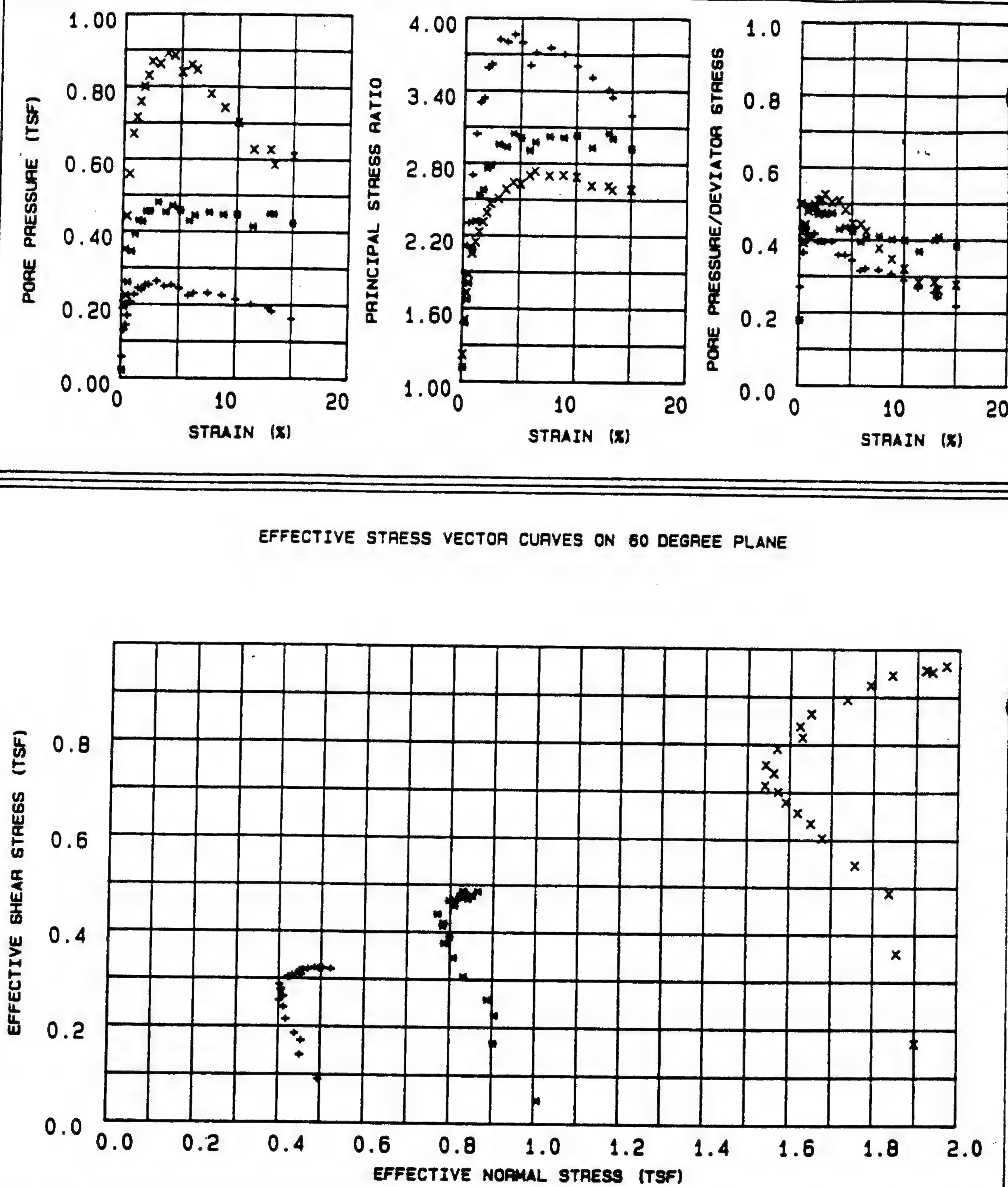
DEPTH ELEV 4'-6'

LABORATORY 89/177 — DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 — PREVIOUS EDITION IS OBSOLETE — TRANSLUCENT — *(EM 1110-2-1906)*

FIGURE 3



LEGEND

+ = .5 TSF
* = 1 TSF
X = 2 TSF

PROJECT	CHASKA; NCS-IA-89-09-ED-GH
BORING NO.	88-102 MU
SAMPLE NO.	1
DEPTH/ELEV	4'-6'
MRD LAB NO.	89/177

Table 4 - Triaxial $\bar{R}$ Test Results

Project : CHASKA: NCS-IA-89-09-ED-GH
Boring Number : 88-102 MU
Sample Number : 1
Depth : 4'-6'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.11	0.212	0.057	1.478	0.270	0.495	0.091
30	0.26	0.327	0.130	1.883	0.397	0.451	0.141
45	0.42	0.397	0.144	2.115	0.364	0.454	0.171
60	0.56	0.431	0.169	2.302	0.393	0.438	0.186
90	0.83	0.499	0.206	2.699	0.415	0.417	0.215
120	1.14	0.557	0.227	3.041	0.409	0.411	0.240
150	1.44	0.588	0.245	3.304	0.417	0.401	0.254
180	1.76	0.609	0.240	3.341	0.394	0.411	0.263
210	2.09	0.640	0.253	3.592	0.396	0.405	0.276
240	2.39	0.644	0.254	3.619	0.395	0.405	0.278
300	3.08	0.668	0.264	3.823	0.395	0.401	0.288
360	3.75	0.700	0.250	3.801	0.358	0.423	0.302
420	4.36	0.707	0.253	3.866	0.358	0.422	0.305
480	5.03	0.713	0.245	3.795	0.344	0.432	0.308
540	5.82	0.717	0.225	3.608	0.315	0.452	0.309
600	6.30	0.725	0.232	3.711	0.321	0.448	0.313
720	7.58	0.737	0.232	3.753	0.316	0.450	0.318
840	8.81	0.740	0.226	3.702	0.306	0.457	0.319
960	9.99	0.743	0.215	3.606	0.289	0.469	0.321
1080	11.35	0.751	0.201	3.514	0.269	0.485	0.324
1200	12.86	0.747	0.191	3.417	0.256	0.494	0.322
1320	13.21	0.748	0.182	3.351	0.243	0.503	0.323
1430	15.00	0.744	0.162	3.198	0.218	0.522	0.321

Table 5 - Triaxial $\bar{R}$ Test Results

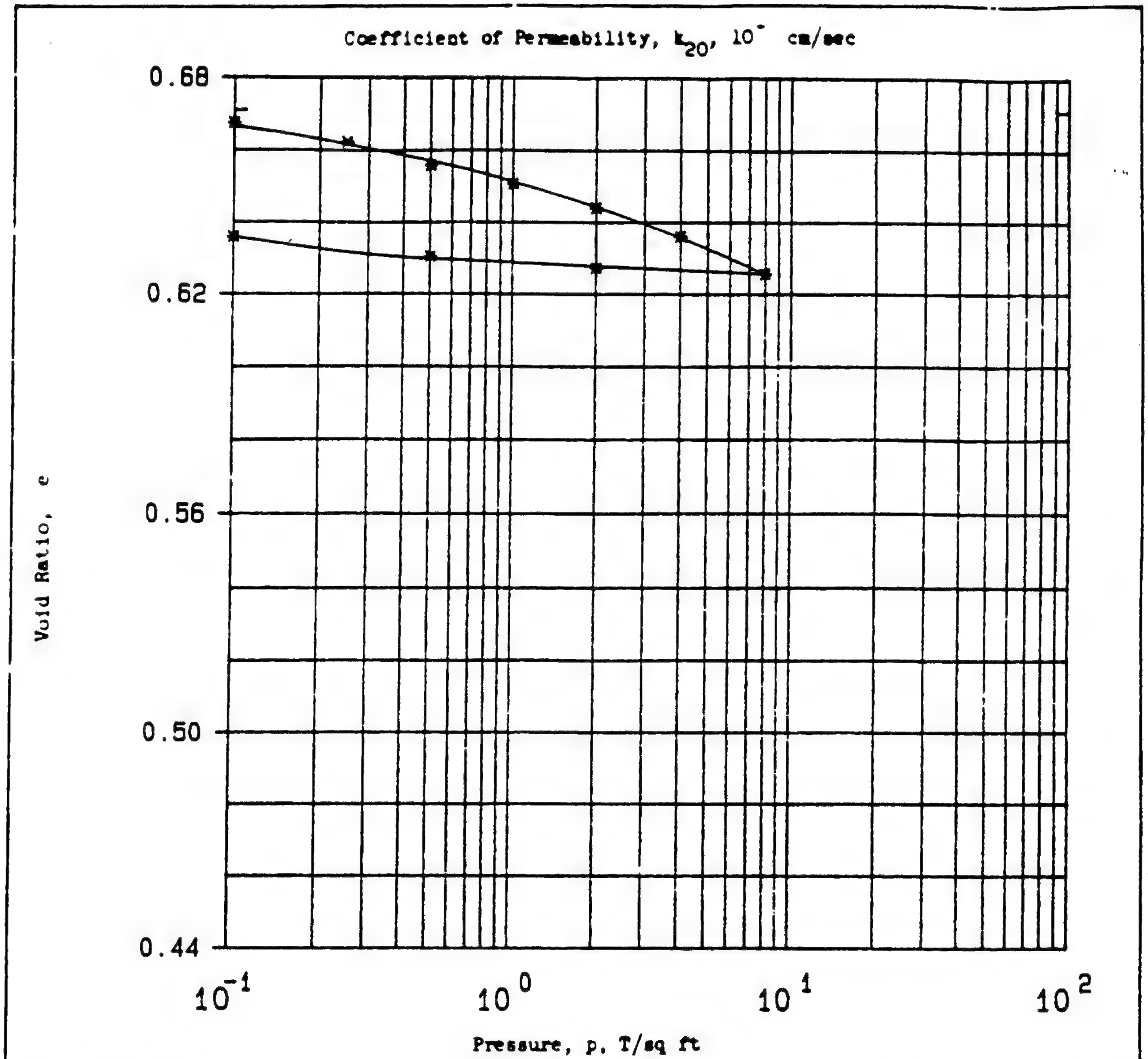
Project : CHASKA; NCS-IA-89-09-ED-GH
Boring Number : 88-102 MU
Sample Number : 1
Depth : 4'-6'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.114	0.020	1.117	0.178	1.008	0.049
30	0.26	0.387	0.193	1.479	0.500	0.903	0.167
45	0.42	0.521	0.224	1.671	0.430	0.905	0.225
60	0.56	0.597	0.260	1.807	0.436	0.888	0.258
90	0.84	0.710	0.344	2.082	0.486	0.832	0.306
120	1.14	0.802	0.391	2.316	0.488	0.807	0.346
150	1.45	0.874	0.430	2.533	0.493	0.786	0.377
180	1.77	0.906	0.426	2.578	0.470	0.798	[illegible]
210	2.10	0.958	0.455	2.756	0.475	0.782	0.413
240	2.40	0.971	0.456	2.785	0.470	0.784	0.419
300	3.10	1.014	0.481	2.954	0.474	0.770	0.438
360	3.78	1.058	0.453	2.934	0.429	0.809	0.456
420	4.38	1.083	0.471	3.045	0.435	0.797	0.467
480	5.06	1.087	0.459	3.009	0.423	0.810	0.469
540	5.85	1.089	0.429	2.905	0.394	0.841	0.470
600	6.34	1.097	0.444	2.974	0.406	0.828	0.473
720	7.62	1.106	0.453	3.022	0.410	0.821	0.477
840	8.86	1.115	0.446	3.012	0.401	0.830	0.481
960	10.05	1.124	0.447	3.033	0.399	0.831	0.485
1080	11.43	1.128	0.415	2.929	0.369	0.864	[illegible]
1200	12.94	1.127	0.450	3.051	0.400	0.829	0.487
1320	13.29	1.102	0.450	3.006	0.409	0.823	0.476
1424	15.00	1.107	0.424	2.922	0.383	0.850	0.478

Table 6 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; NCS-IA-89-09-ED-GH
Boring Number : 88-102 MU
Sample Number : 1
Depth : 4'-6'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.397	0.198	1.220	0.498	1.900	0.171
30	0.26	0.834	0.349	1.505	0.419	1.857	0.360
45	0.42	1.130	0.441	1.725	0.391	1.839	0.488
60	0.56	1.267	0.558	1.878	0.441	1.756	0.547
90	0.84	1.399	0.669	2.051	0.479	1.677	0.604
120	1.14	1.471	0.714	2.144	0.486	1.650	0.635
150	1.44	1.523	0.758	2.227	0.498	1.619	0.657
180	1.77	1.574	0.799	2.310	0.508	1.591	0.679
210	2.10	1.624	0.829	2.387	0.511	1.573	0.701
240	2.40	1.655	0.868	2.462	0.525	1.542	0.714
300	3.10	1.714	0.861	2.505	0.503	1.563	0.740
360	3.77	1.754	0.891	2.582	0.509	1.543	0.757
420	4.38	1.833	0.884	2.642	0.483	1.570	0.791
480	5.05	1.889	0.839	2.627	0.445	1.629	0.815
540	5.85	1.941	0.858	2.699	0.443	1.623	0.838
600	6.34	2.001	0.846	2.735	0.423	1.649	0.864
720	7.62	2.072	0.779	2.696	0.376	1.734	0.894
840	8.85	2.141	0.741	2.701	0.347	1.789	0.924
960	10.04	2.192	0.701	2.687	0.320	1.842	0.946
1080	11.41	2.216	0.627	2.614	0.284	1.922	0.956
1200	12.93	2.215	0.627	2.613	0.284	1.921	0.956
1320	13.28	2.237	0.585	2.581	0.262	1.969	0.965
1425	15.00	2.205	0.609	2.586	0.277	1.936	0.952

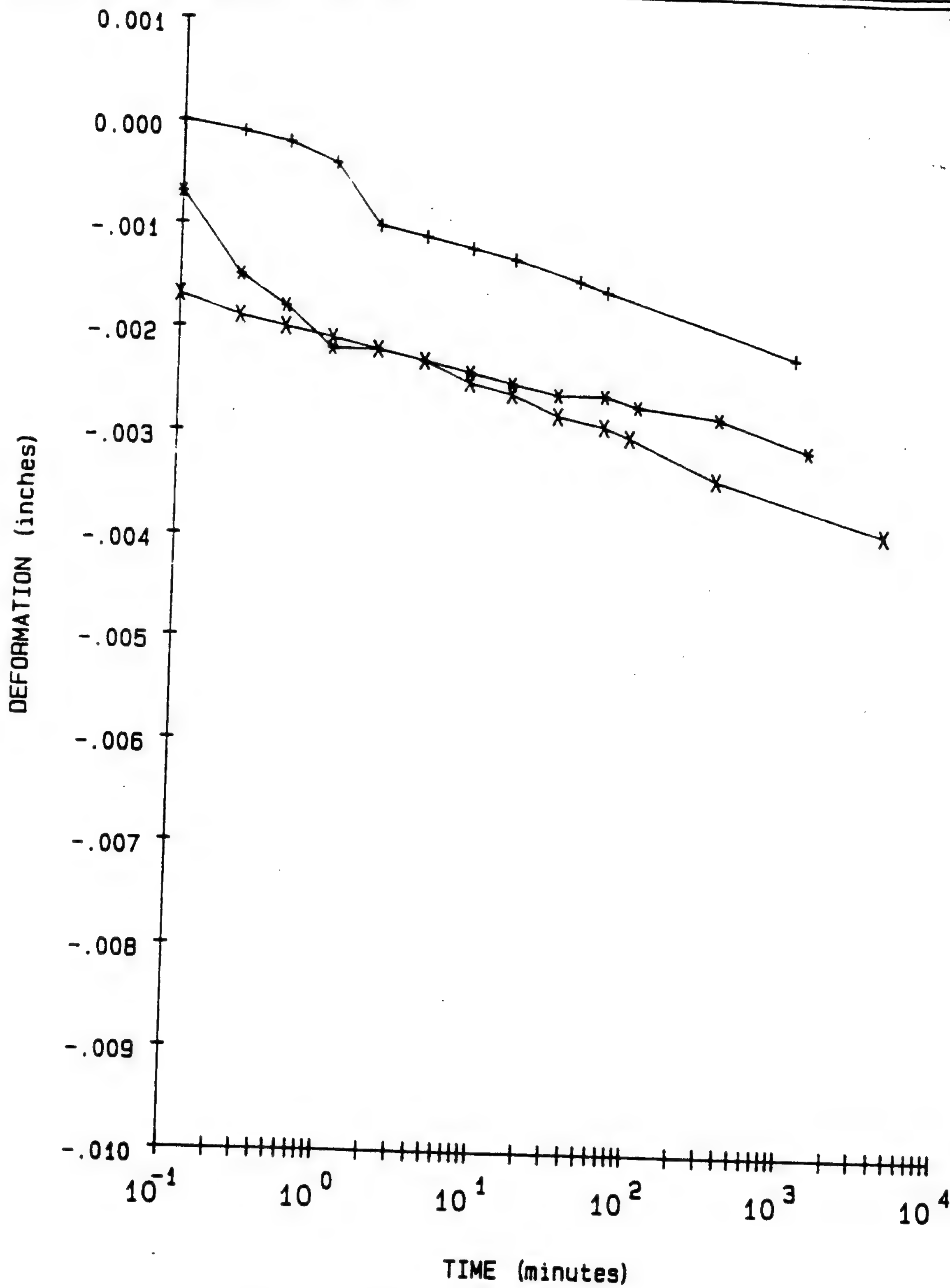


not enough undisturbed soil for Rbar test

Type of Specimen	UNDISTURBED	Before Test		After Test	
Diam 4.3 in.	Ht 1 in.	Water Content, w_o	23.1 %	w_f	23.3 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	0.67	e_f	0.64
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	93 %	S_f	99 %
Compression Index, C_c		Dry Density, γ_d	101.2 lb/ft^3		
Classification Silt, ML		k_{20} at e_o = x 10^{-} cm/sec			
LL 23	G_s 2.71	Project	CHASKA; NCS-IA-89-09-ED-GH		
PL 19	D_{10}				
Remarks Brown gray, calcareous.		Area	MRD LAB NO. 89/177		
Sample may have dried due to a		Boring No.	88-102 MU	Sample No.	3
hole in the plastic field		Depth El	23'-25'	Date	
packaging.		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

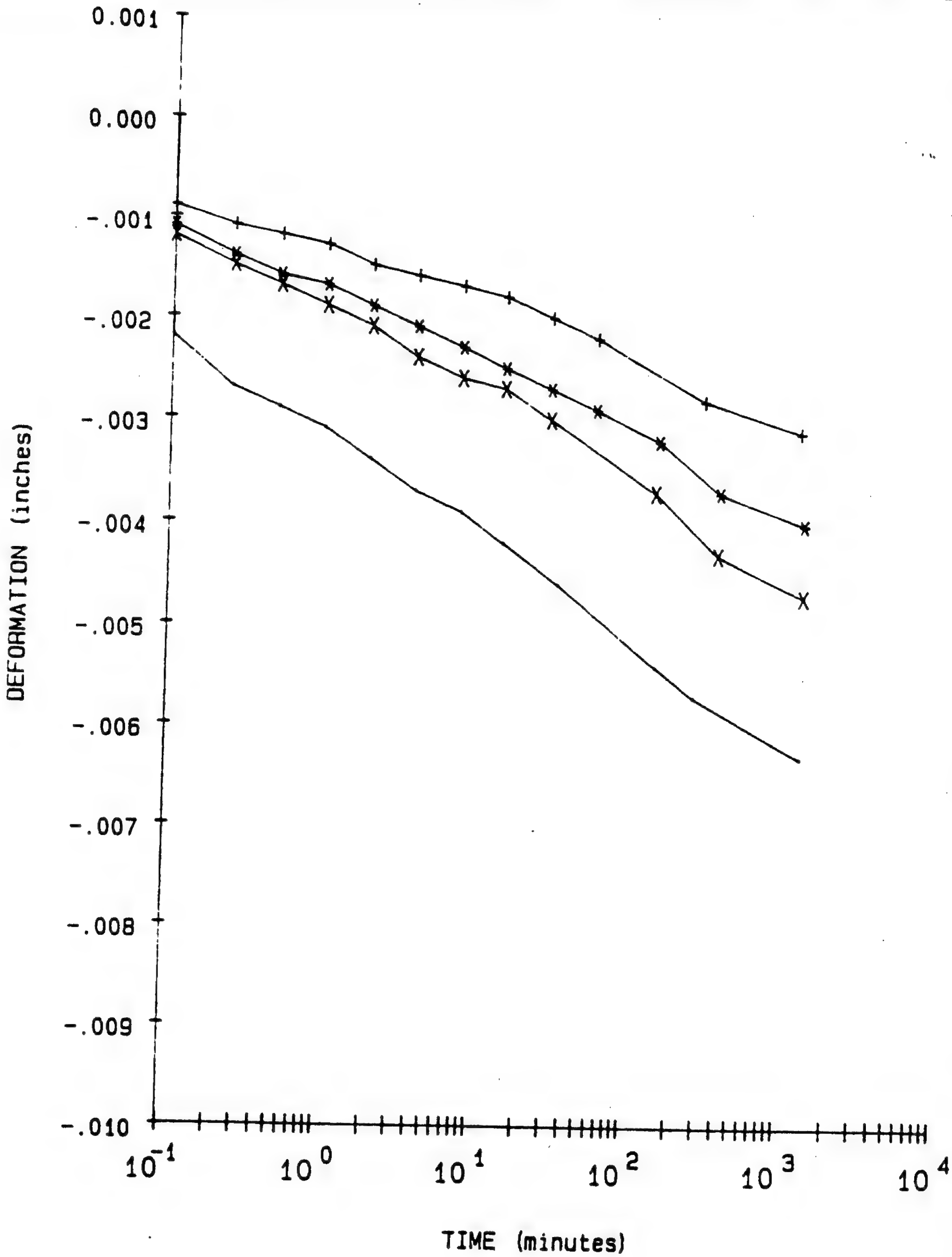
Figure 6



LEGEND
+ = .1 TSF
* = .25 TSF
X = .5 TSF

PROJECT	CHASKA; NCS-IA-89-09-ED-GH
BORING NO.	88-102 MU
SAMPLE NO.	3
DEPTH/ELEV	23'-25'
MRD LAB NO.	89/177

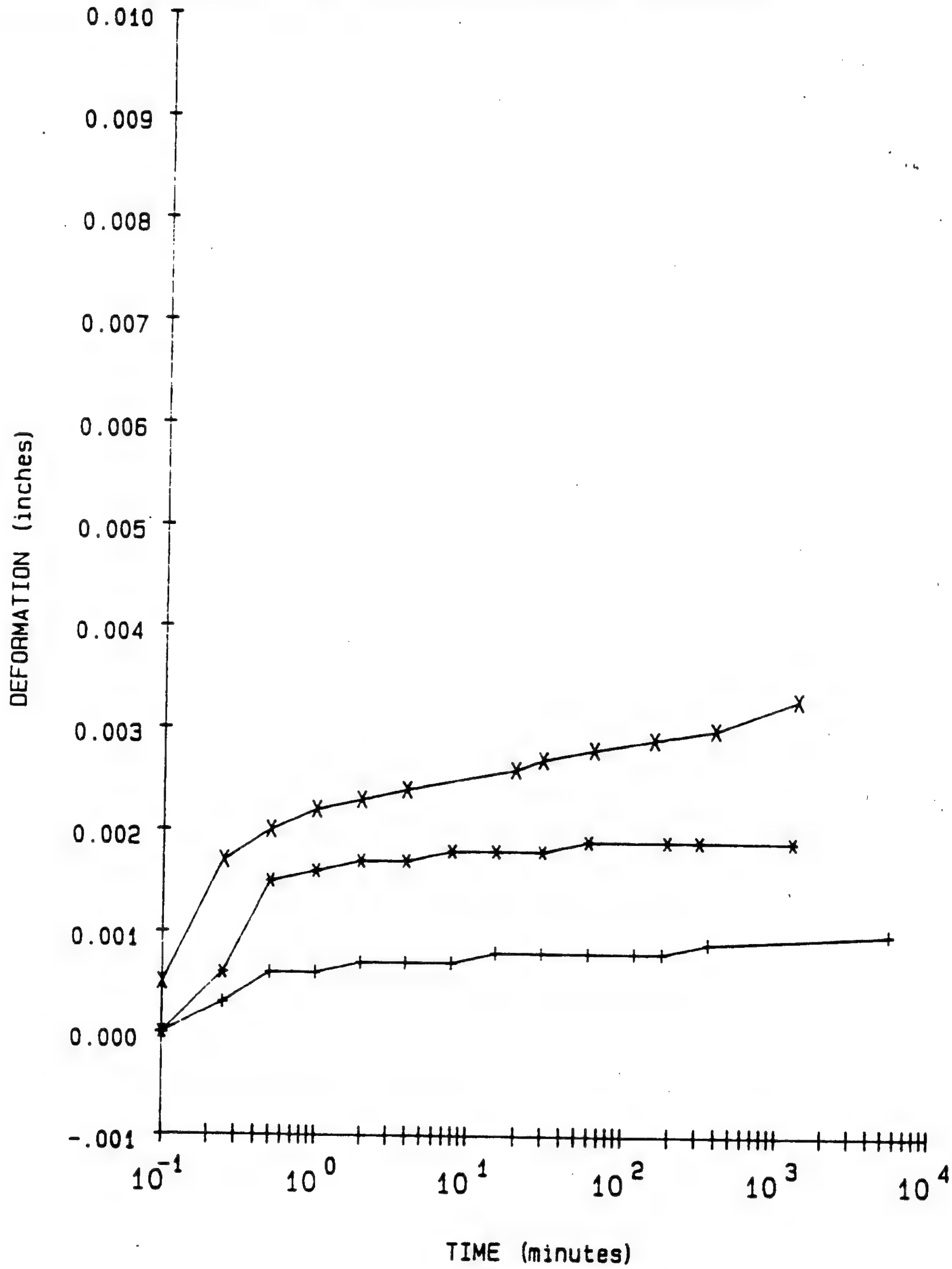
Figure 7 Figure C-235



LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	CHASKA: NCS-IA-89-09-ED-GH
BORING NO.	88-102 MU
SAMPLE NO.	3
DEPTH/ELEV	23'-25'
MRD LAB NO.	89/177

FIGURE 8



LEGEND

+ = 2 TSF
* = .5 TSF
X = .1 TSF

PROJECT	CHASKA; NCS-IA-89-09-ED-GH
BORING NO.	88-102 MU
SAMPLE NO.	3
DEPTH/ELEV	23'-25'
MRD LAB NO.	89/177

FIGURE 9

Figure C-237

Consolidation Test Data

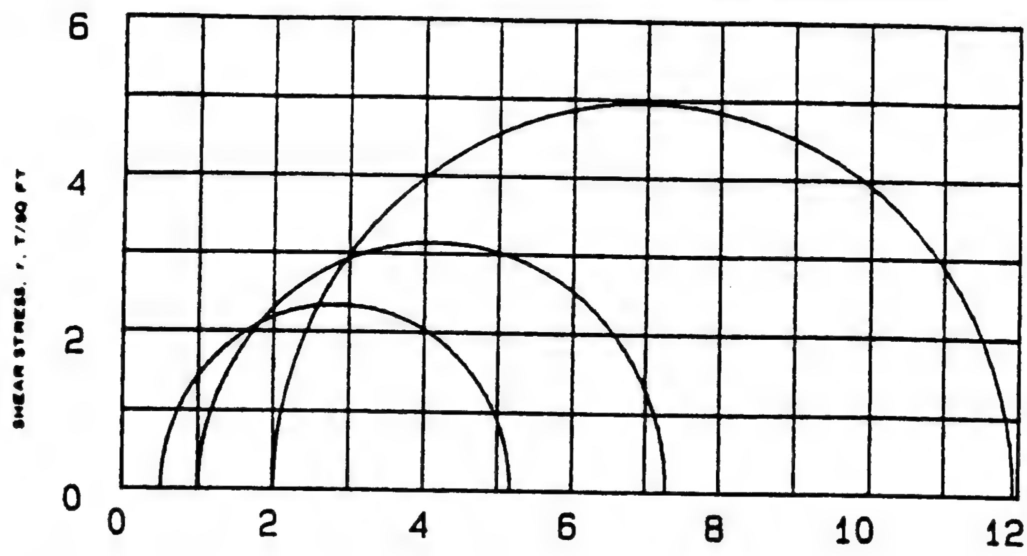
Table 2

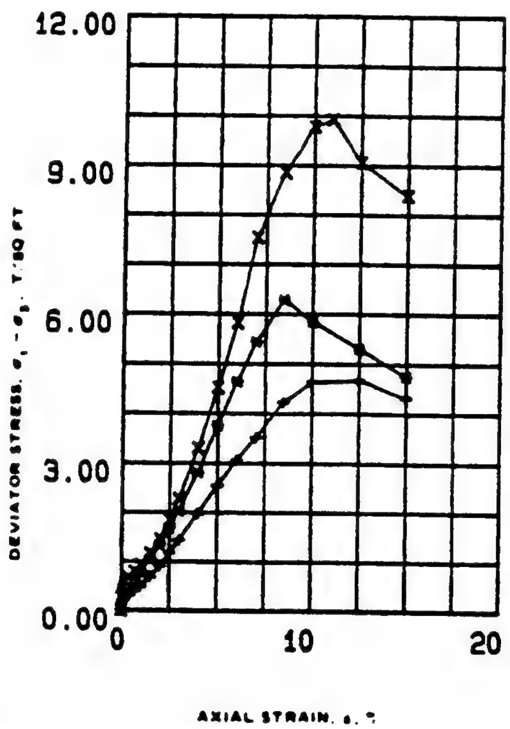
Project	CHASKA; NCS-IA-89-09-ED-GH
Boring No.	88-102 MU
Sample No.	3
Depth/Elev	23'-25'
MRD Lab No.	89/177

Gs = 2.71
eo = 0.671
0.42eo = 0.282

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
23.1	382.7	101.2	0.671	0.10	93.2
23.3	382.7	101.4	0.667	0.25	94.6
23.3	382.7	101.7	0.662	0.50	95.4
23.3	382.7	102.1	0.656	1.00	96.3
23.3	382.7	102.5	0.651	2.00	97.1
23.3	382.7	102.9	0.644	4.00	98.1
23.3	382.7	103.4	0.636	8.00	99.3
23.3	382.7	104.0	0.625	2.00	100.0
23.3	382.7	103.9	0.627	0.50	100.0
23.3	382.7	103.7	0.630	0.10	100.0
23.3	382.7	103.4	0.636		99.3

Axial Strain (%)	Void Ratio
1	0.654
2	0.638
3	0.621
4	0.604
5	0.588





SPECIMEN NO.			1 (+)	2 (✱)	3 (X)
INITIAL	WATER CONTENT, %	w_o	19.5	19.6	18.9
	DRY DENSITY LB/CU FT	γd_o	110.7	110.1	110.3
	SATURATION, %	S_o	100.0	99.0	96.0
	VOID RATIO	e_o	0.53	0.54	0.53
BEFORE SHEAR	WATER CONTENT, %	w_c	19.3	19.6	19.3
	DRY DENSITY LB/CU FT	γd_c	110.7	110.1	110.5
	SATURATION, %	S_c	99.0	99.0	98.0
	VOID RATIO	e_c	0.53	0.54	0.53
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	4.67	6.28	9.92
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	27.5	21.5	30.0
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	4.31	4.74	8.39
INITIAL DIAMETER, IN.		D_o	1.40	1.41	1.40
INITIAL HEIGHT, IN		H_o	2.99	2.98	2.99

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Silt, ML

LL 23 | PL 19 | PI 4 | Gs 2.71

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST Q

REMARKS Brown gray, calcareous. Too brittle for Torvane. A hole was found in the protective cover of this sample when it arrived from the field. This may have resulted in some drying of the sample.

PROJECT CHASKA: NCS-IA-89-09-ED-GH

BORING NO 88-102 MU | SAMPLE NO. 3

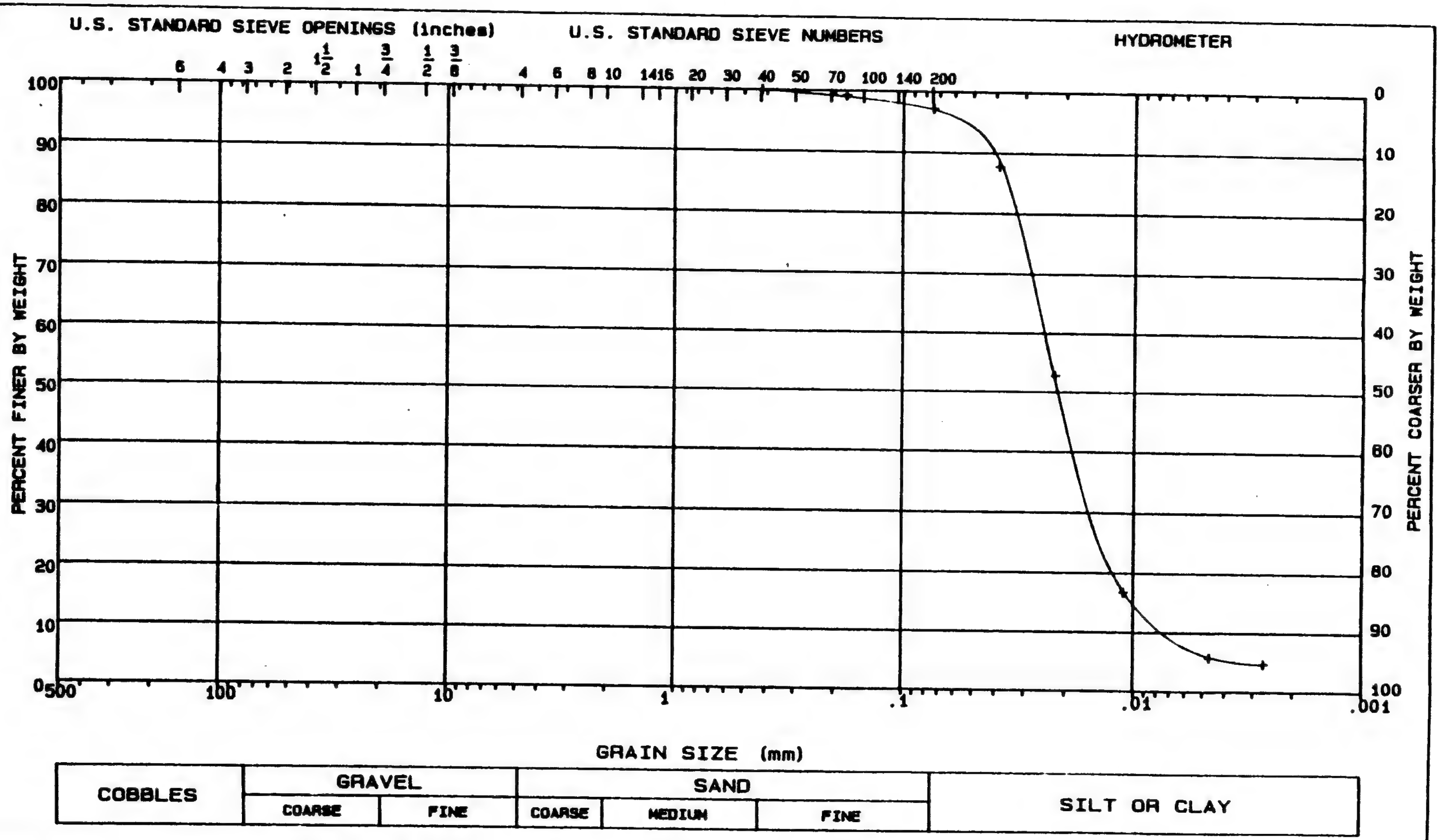
DEPTH ELEV 23'-25'

LABORATORY 89/177 | DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 5
REV JUNE 1970

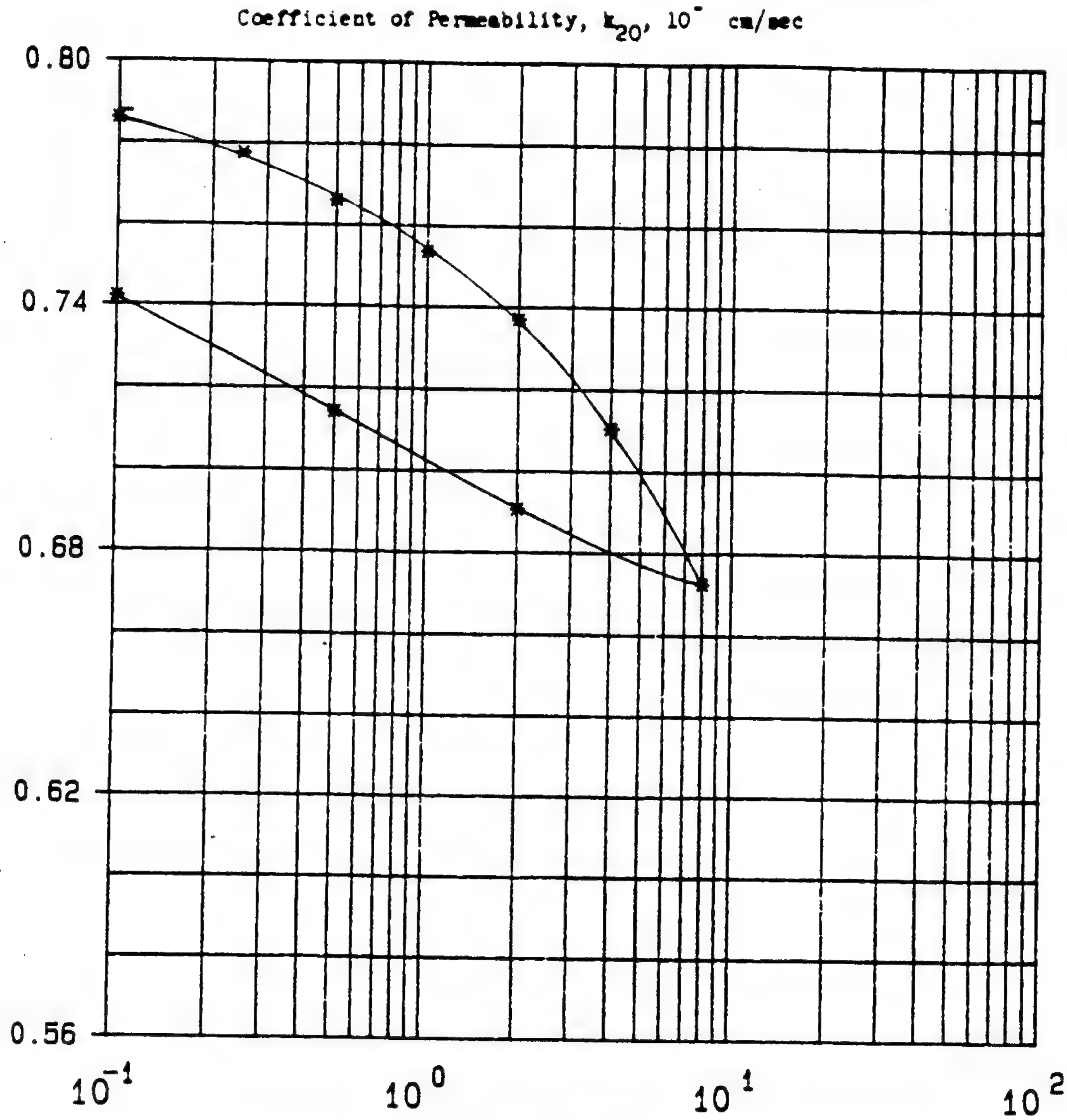
Figure C-239



LL = 23	PL = 19	PI = 4	Gs = 2.71	NAT w = %	PROJECT	CHASKA; NCS-IA-89-09-ED-GH
CLASSIFICATION Silt, ML Trimmings from Q test					BORING NO.	88-102 MU
					SAMPLE NO.	3
					DEPTH/ELEV	23'-25'
GRADATION CURVE					MRD LAB NO.	89/177

FIGURE 6

Figure C-240



Type of Specimen	UNDISTURBED			Before Test		After Test	
Diam	4.4 in.	Ht	1 in.	Water Content, w_o	28.4 %	w_f	27.6 %
Overburden Pressure, p_o	T/sq ft			Void Ratio, e_o	0.79	e_f	0.74
Preconsol. Pressure, p_c	T/sq ft			Saturation, S_o	99 %	S_f	100 %
Compression Index, C_c				Dry Density, γ_d	95.6 lb/ft^3		
Classification	Lean clay, CL			k_{20} at e_o =	x 10^{-} cm/sec		
LL	46	G_s	2.74				
PL	18	D_{10}					

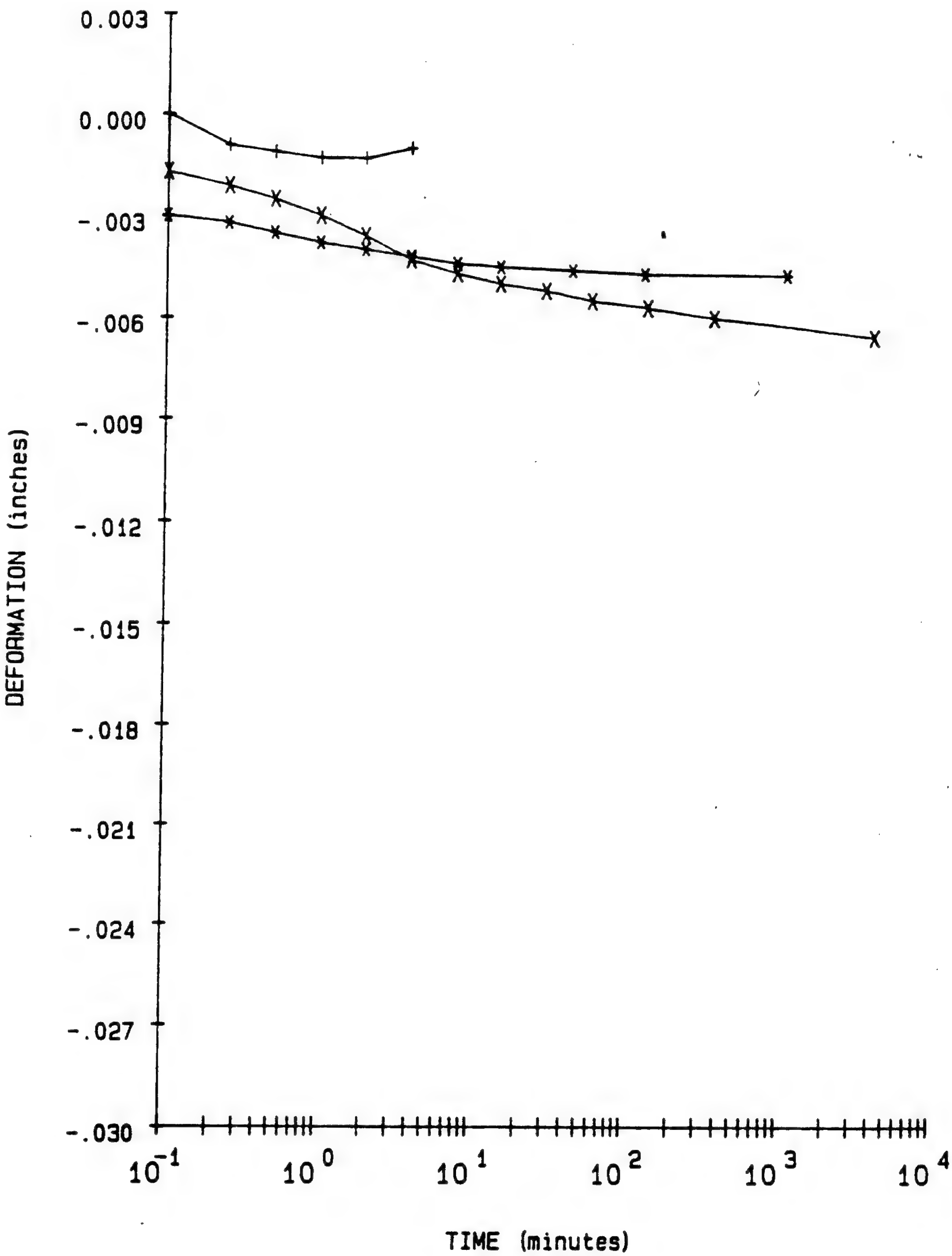
Remarks Brown gray, calcareous.	
Torvane=0.8 TSF.	

Project	CHASKA: NCS-IA-89-09-ED-GH		
Area	MRD LAB NO. 89/177		
Boring No.	88-102 MU	Sample No.	5
Depth El	43'-45'	Date	

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 7



LEGEND

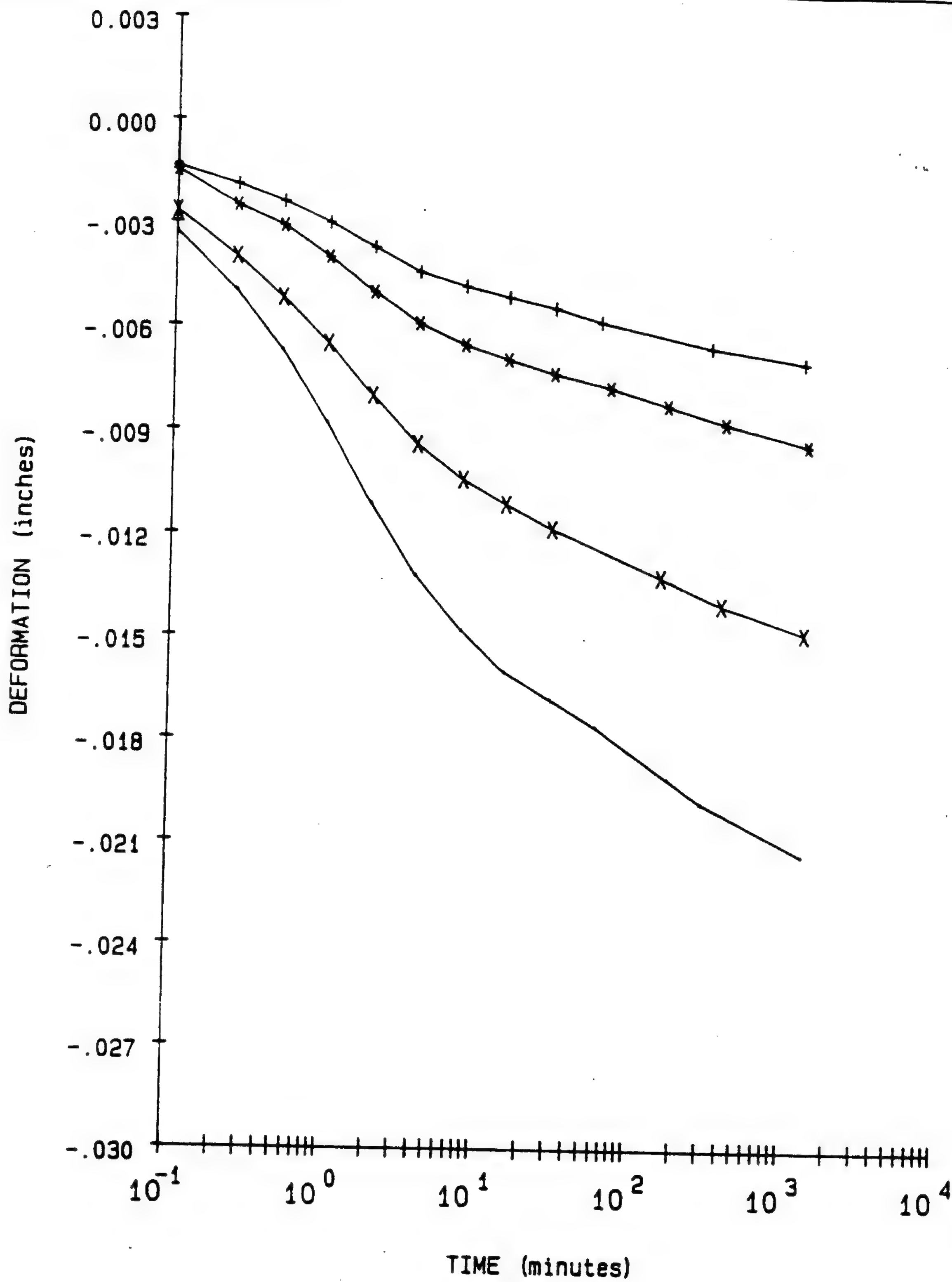
+ = .1 TSF

* = .25 TSF

X = .5 TSF

PROJECT	CHASKA: NCS-IA-89-09-ED-GH
BORING NO.	88-102 MU
SAMPLE NO.	5
DEPTH/ELEV	43'-45'
MRD LAB NO.	89/177

FIGURE 8

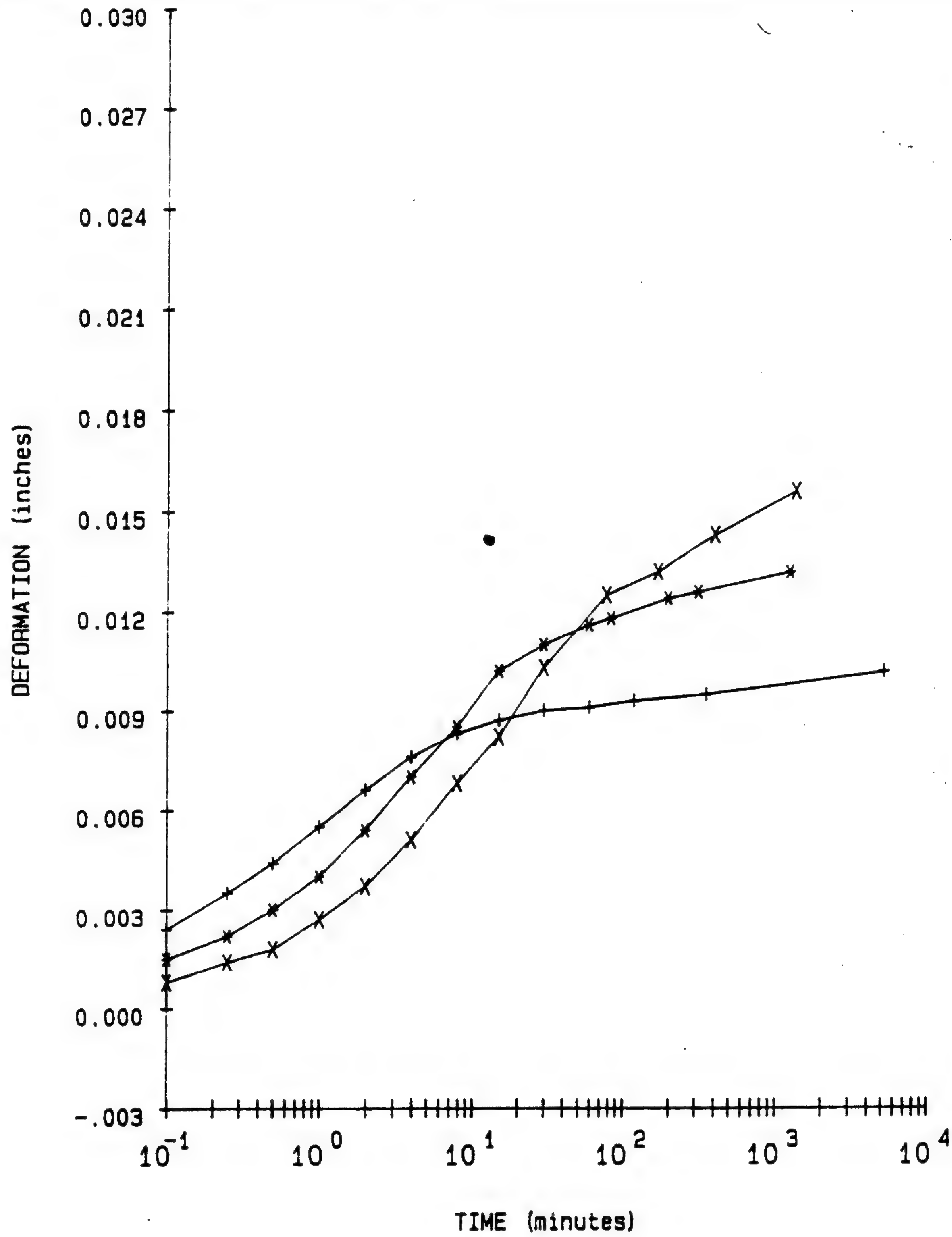


LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF
- = 8 TSF

PROJECT	CHASKA: NCS-IA-89-09-ED-GH
BORING NO.	88-102 MU
SAMPLE NO.	5
DEPTH/ELEV	43'-45'
MRO LAB NO.	89/177

FIGURE 9



LEGEND

+ = 2 TSF Rebound

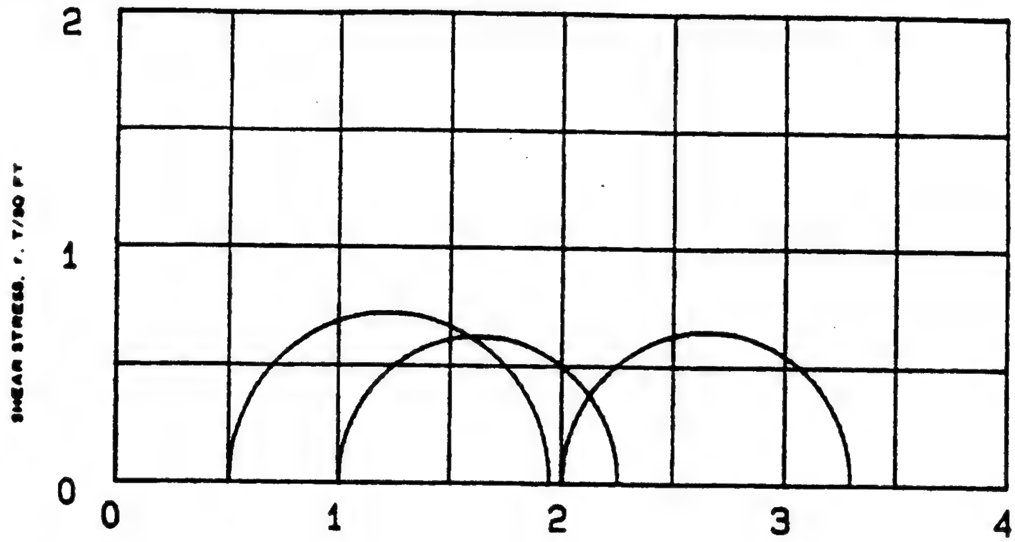
* = .5 TSF Rebound

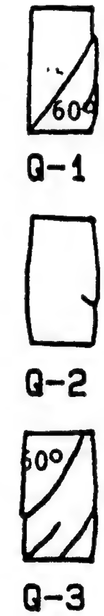
X = .1 TSF Rebound

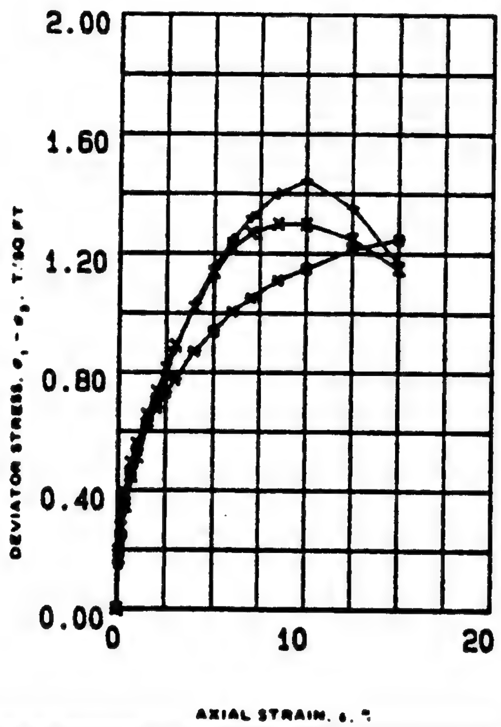
PROJECT	CHASKA: NCS-IA-89-09-ED-GH
BORING NO.	88-102 MU
SAMPLE NO.	5
DEPTH/ELEV	43'-45'
MRD LAB NO.	89/177

FIGURE 10

Figure C-24







SPECIMEN NO.			1 (+)	2 (×)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	27.2	33.1	28.9	
	DRY DENSITY LB/CU FT	γd_o	97.9	89.4	95.4	
	SATURATION, %	S_o	100.0	99.0	100.0	
	VOID RATIO	e_o	0.75	0.91	0.79	
BEFORE SHEAR	WATER CONTENT, %	w_c	27.2	33.0	29.1	
	DRY DENSITY LB/CU FT	γd_c	97.9	89.4	95.4	
	SATURATION, %	S_c	100.0	99.0	100.0	
	VOID RATIO	e_c	0.75	0.91	0.79	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.44	1.25	1.30	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	19.0	30.0	17.3	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.17	1.25	1.15	
INITIAL DIAMETER, IN.		D_o	1.40	1.40	1.40	
INITIAL HEIGHT, IN.		H_o	2.98	2.98	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL

LL 46	PL 18	PI 28	G_s 2.74 Est.	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

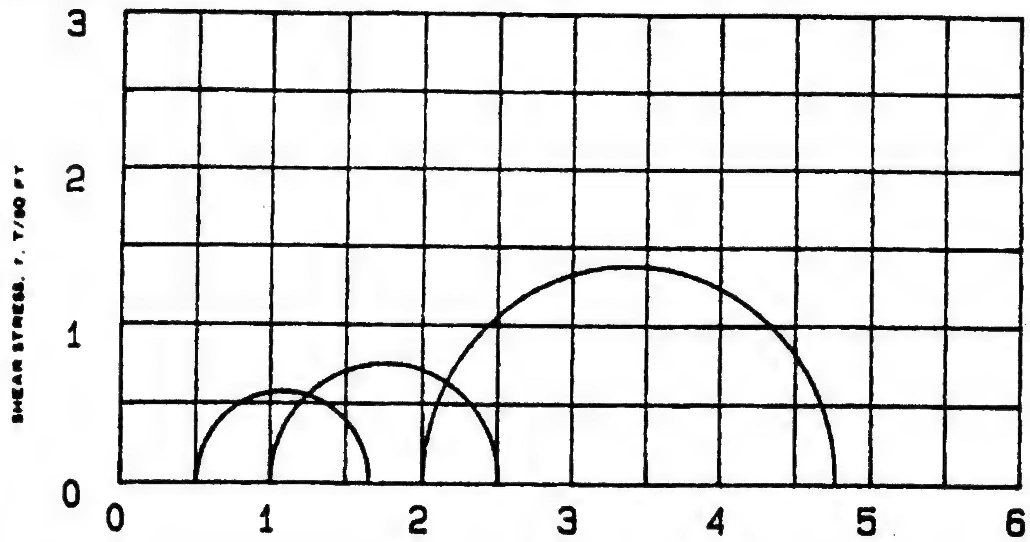
REMARKS: Brown gray, calcareous.
Torvane=0.3 TSF.

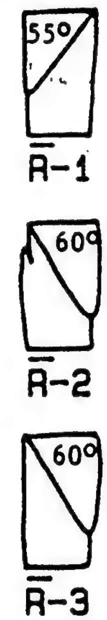
PROJECT CHASKA; NCS-IA-88-09-ED-GH

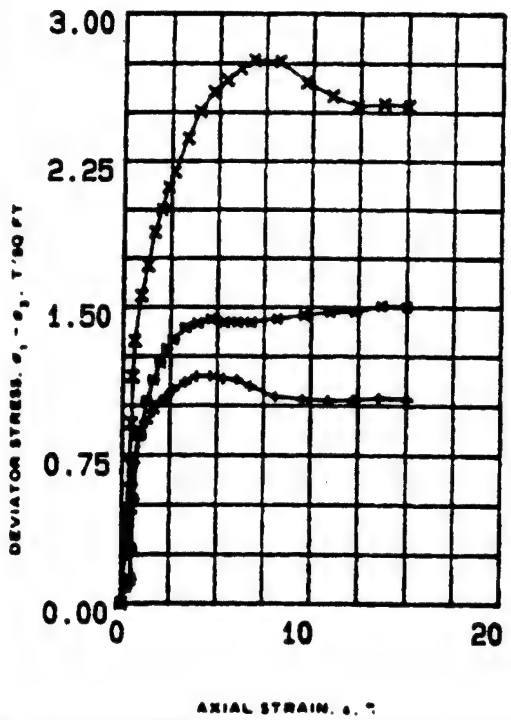
BORING NO 88-102 MU	SAMPLE NO. 5
DEPTH ELEV 43'-45'	
LABORATORY 88/177	DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 15
REV JUNE 1970







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	29.3	29	24.3	
	DRY DENSITY LB/CU FT	γ_{d_o}	84.6	95.1	102.8	
	SATURATION, %	S_o	99	99	100	
	VOID RATIO	e_o	.81	.8	.86	
BEFORE SHEAR	WATER CONTENT, %	w_c	29.3	28.3	22.7	
	DRY DENSITY LB/CU FT	γ_{d_c}	84.4	96.8	105.6	
	SATURATION, %	S_c	99	100	100	
	VOID RATIO	e_c	.81	.77	.82	
	FINAL BACK PRESSURE, T/SQ FT	u_o	2.883	2.883	2.883	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.15	1.508	2.765	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	420	1200	800	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.03	1.502	2.832	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.38	
INITIAL HEIGHT, IN.		H_o	3	3	3	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL

LL 46	PL 18	PI 28	Gs 2.74	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Brown gray, calcareous.
Torvane=0.8 TSF.

PROJECT CHASKA: NCS-IA-88-09-ED-SH

BORING NO 88-102 NU SAMPLE NO. 5

DEPTH ELEV 43'-45'

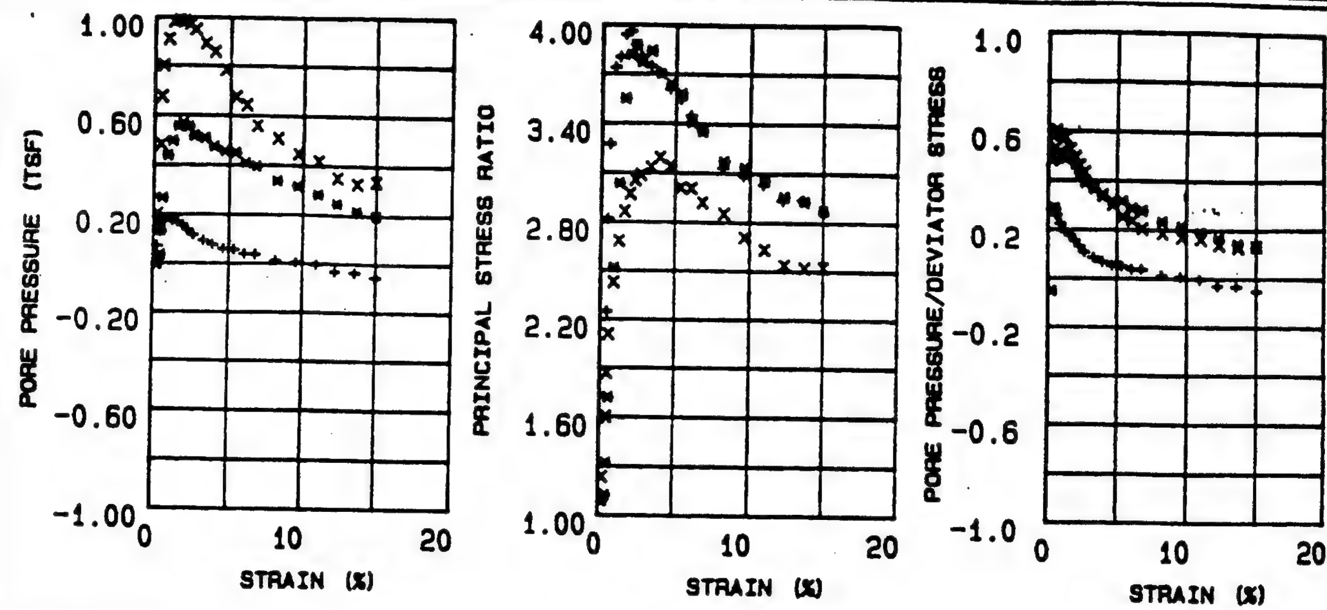
LABORATORY 88/177 DATE

TRIAXIAL COMPRESSION TEST REPORT

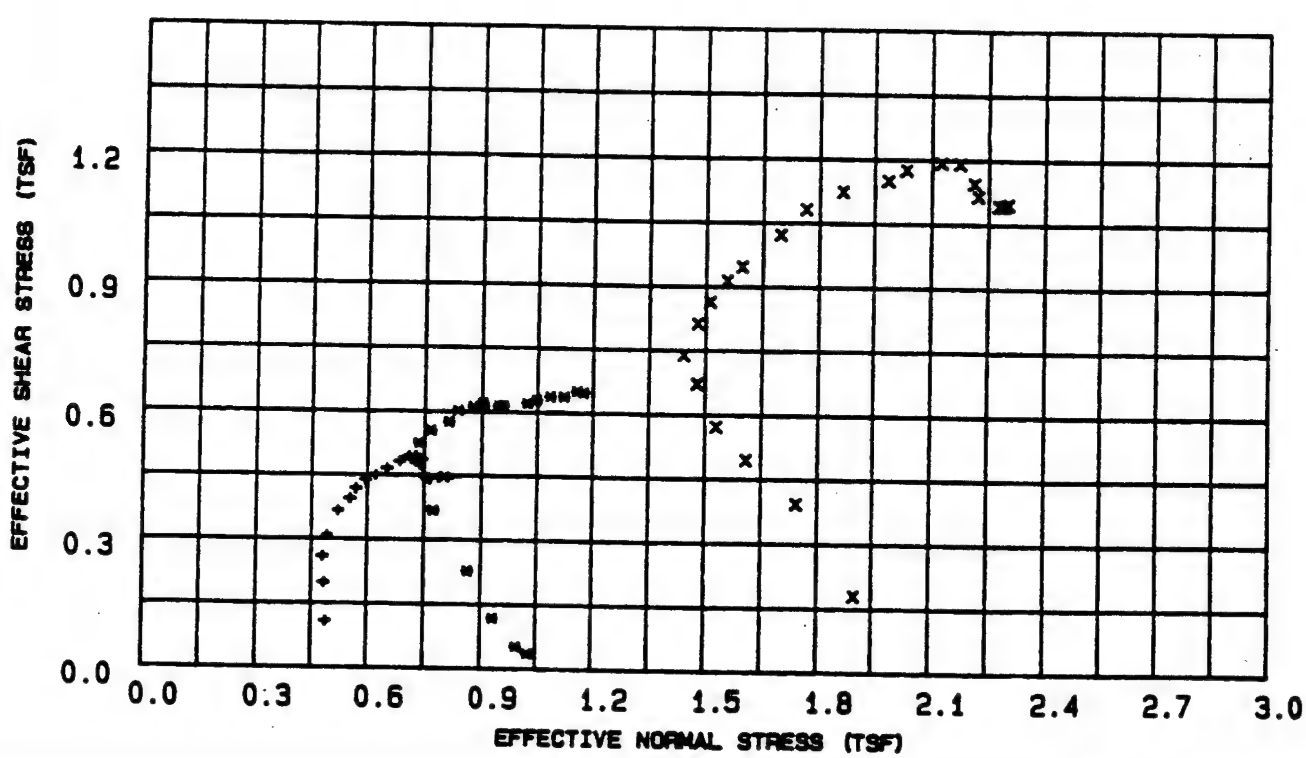
ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 16

Figure C-246



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



28°

LEGEND

+ = .5 TSF

✱ = 1 TSF

X = 2 TSF

PROJECT	CHASKA: NCS-IA-89-09-ED-GH
BORING NO.	88-102 MU
SAMPLE NO.	5
DEPTH/ELEV	43'-45'
MRD LAB NO.	89/177

FIGURE 17

Table 4 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; NCS-IA-89-09-ED-GH
Boring Number : 88-102 MU
Sample Number : 5
Depth : 43'-45'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.28	0.252	0.072	1.589	0.285	0.490	0.109
30	0.49	0.462	0.130	2.249	0.283	0.484	0.199
45	0.51	0.602	0.169	2.820	0.281	0.480	0.260
60	0.61	0.716	0.185	3.272	0.259	0.492	0.309
90	0.91	0.851	0.189	3.740	0.223	0.522	0.367
120	1.24	0.916	0.173	3.803	0.190	0.554	0.395
150	1.59	0.970	0.170	3.941	0.176	0.570	0.419
180	1.94	1.016	0.157	3.964	0.155	0.595	0.[illegible]
210	2.27	1.044	0.137	3.876	0.132	0.622	0.451
240	2.64	1.080	0.116	3.809	0.107	0.651	0.466
300	3.31	1.118	0.093	3.747	0.084	0.684	0.483
360	3.92	1.148	0.076	3.707	0.067	0.708	0.495
420	4.62	1.150	0.059	3.607	0.052	0.726	0.496
480	5.32	1.135	0.055	3.549	0.049	0.726	0.490
540	6.02	1.129	0.038	3.446	0.035	0.741	0.487
600	6.75	1.097	0.036	3.366	0.034	0.736	0.473
720	8.17	1.043	0.011	3.131	0.011	0.747	0.450
840	9.55	1.030	0.004	3.078	0.005	0.751	0.445
960	10.91	1.026	-0.005	3.030	-0.005	0.759	0.443
1080	12.21	1.029	-0.032	2.935	-0.031	0.787	0.444
1200	13.57	1.039	-0.036	2.937	-0.034	0.793	0.4[illegible]
1316	15.00	1.030	-0.055	2.856	-0.053	0.811	0.445

Table 5 - Triaxial $\bar{R}$ Test Results

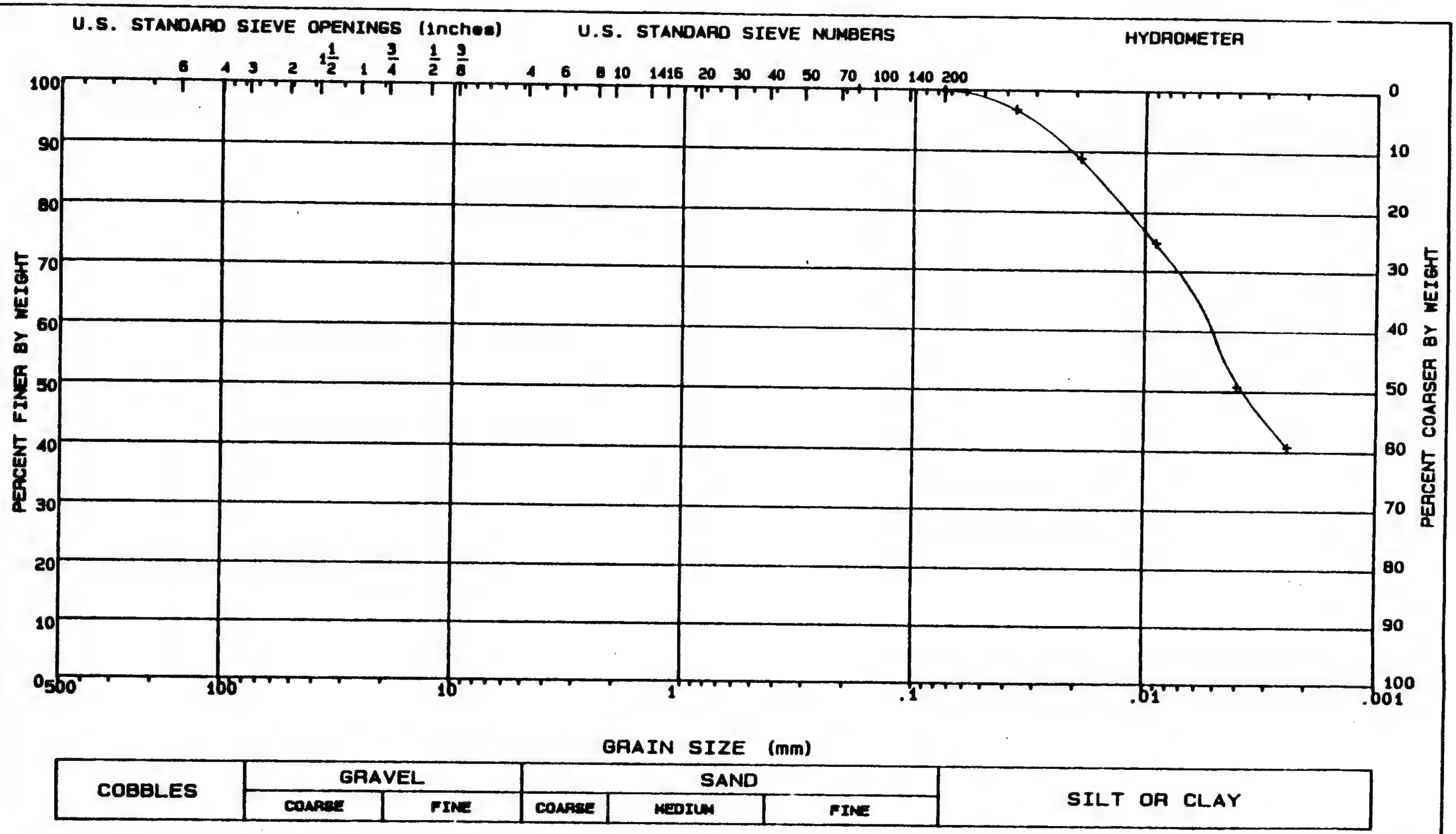
Project : CHASKA; NCS-IA-89-09-ED-GH
Boring Number : 88-102 MU
Sample Number : 5
Depth : 43'-45'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.28	0.084	-0.005	1.084	-0.053	1.026	0.036
30	0.49	0.121	0.035	1.125	0.286	0.995	0.052
45	0.52	0.277	0.136	1.320	0.490	0.932	0.119
60	0.61	0.528	0.267	1.720	0.505	0.864	0.228
90	0.92	0.853	0.438	2.519	0.514	0.773	0.368
120	1.25	1.021	0.498	3.036	0.489	0.755	0.441
150	1.60	1.130	0.557	3.551	0.494	0.723	0.488
180	1.95	1.218	0.568	3.818	0.466	0.734	0.526
210	2.29	1.288	0.553	3.878	0.430	0.766	0.556
240	2.66	1.336	0.518	3.772	0.388	0.813	0.577
300	3.34	1.396	0.509	3.843	0.365	0.837	0.603
360	3.96	1.419	0.474	3.700	0.335	0.877	0.613
420	4.66	1.440	0.455	3.640	0.316	0.901	0.621
480	5.37	1.422	0.449	3.580	0.316	0.903	0.614
540	6.07	1.423	0.408	3.405	0.287	0.944	0.614
600	6.81	1.424	0.395	3.352	0.278	0.957	0.615
720	8.24	1.442	0.336	3.171	0.233	1.021	0.622
840	9.63	1.460	0.315	3.131	0.216	1.047	0.630
960	11.00	1.477	0.282	3.056	0.191	1.084	0.638
1080	12.32	1.477	0.245	2.958	0.167	1.121	0.638
1200	13.68	1.508	0.217	2.926	0.144	1.156	0.651
1306	15.00	1.502	0.198	2.873	0.132	1.174	0.648

Table 6 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; NCS-IA-89-09-ED-GH
Boring Number : 88-102 MU
Sample Number : 5
Depth : 43'-45'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.28	0.418	0.202	1.233	0.483	1.902	0.180
30	0.49	0.910	0.482	1.599	0.530	1.743	0.393
45	0.52	1.147	0.675	1.866	0.589	1.609	0.495
60	0.61	1.328	0.800	2.107	0.603	1.529	0.573
90	0.92	1.558	0.909	2.428	0.584	1.477	0.672
120	1.25	1.713	0.982	2.683	0.574	1.442	0.739
150	1.60	1.885	0.989	2.864	0.525	1.478	0.813
180	1.96	2.001	0.985	2.972	0.493	1.510	0.[illegible]
210	2.29	2.117	0.970	3.056	0.459	1.554	0.914
240	2.67	2.195	0.949	3.088	0.433	1.594	0.947
300	3.35	2.368	0.890	3.134	0.376	1.696	1.022
360	3.96	2.506	0.857	3.193	0.342	1.764	1.082
420	4.67	2.604	0.782	3.138	0.301	1.863	1.124
480	5.38	2.665	0.674	3.009	0.253	1.986	1.150
540	6.09	2.725	0.642	3.006	0.236	2.033	1.176
600	6.82	2.765	0.559	2.918	0.203	2.125	1.193
720	8.26	2.759	0.509	2.850	0.185	2.174	1.191
840	9.65	2.653	0.445	2.707	0.168	2.212	1.145
960	11.02	2.583	0.417	2.632	0.162	2.223	1.115
1080	12.34	2.532	0.350	2.535	0.139	2.277	1.0[illegible]
1200	13.71	2.542	0.327	2.519	0.129	2.302	1.097
1304	15.00	2.532	0.337	2.522	0.133	2.290	1.093



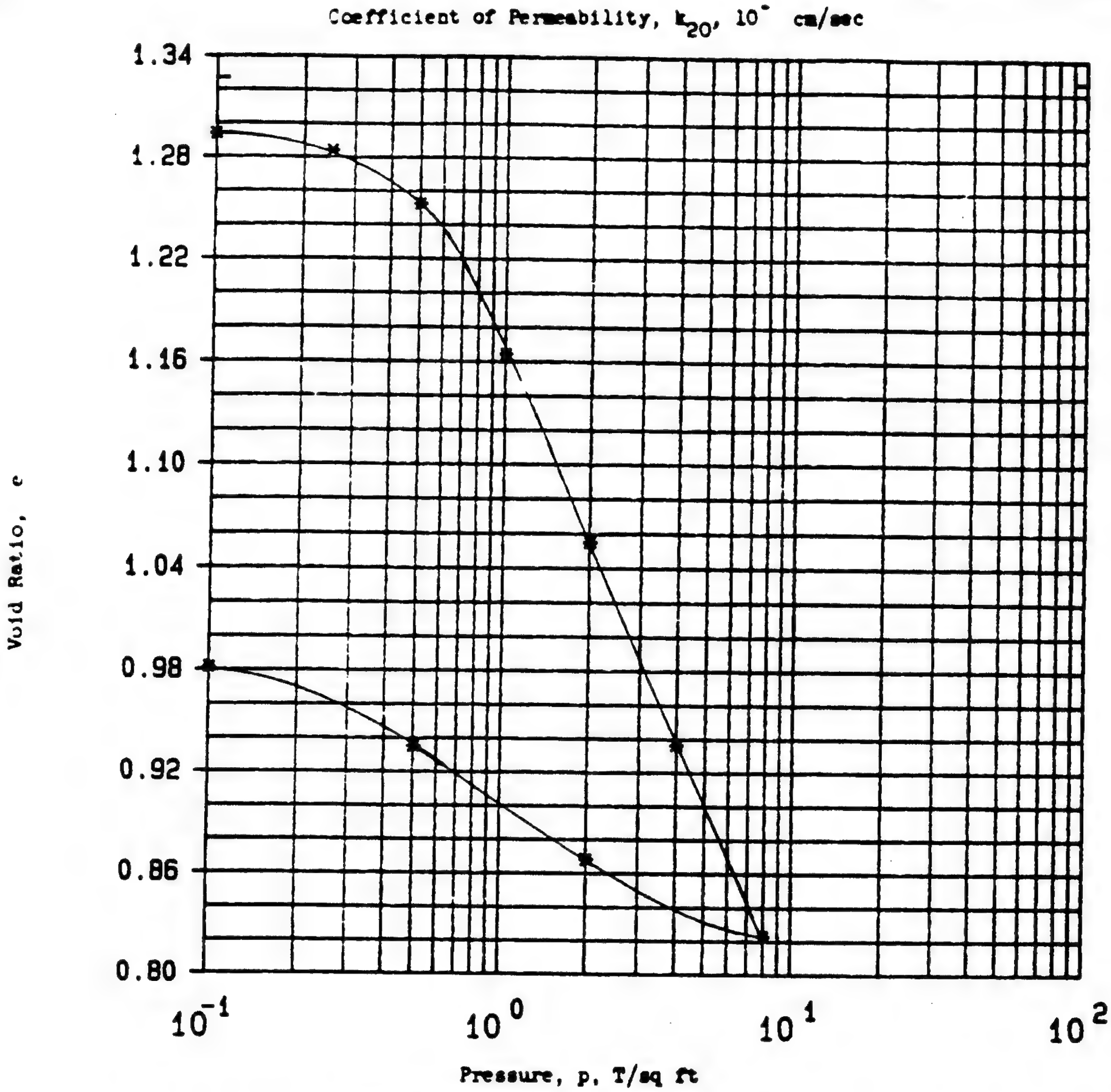
LL = 46	PL = 18	PI = 28	Gs = 2.74	NAT w = %

CLASSIFICATION Lean clay, CL
Classification tests run on trimmings from Q-test.

GRADATION CURVE

PROJECT	CHASKA: NCS-IA-89-09-ED-GH
BORING NO.	88-102 MU
SAMPLE NO.	5
DEPTH/ELEV	43'-45'
MRD LAB NO.	89/177

FIGURE 18



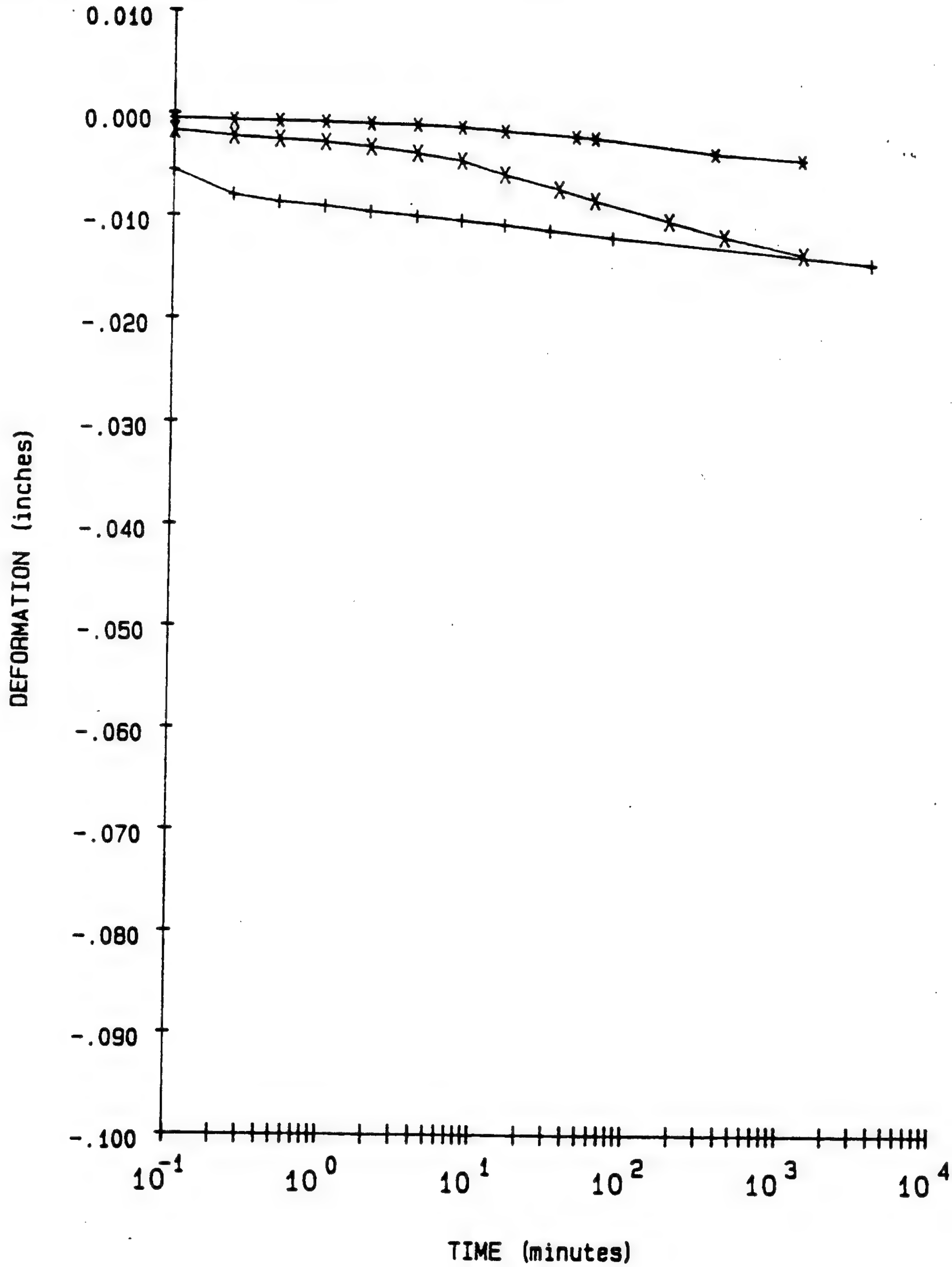
Type of Specimen UNDISTURBED		Before Test	After Test
Diam 4.3 in.	Ht 1 in.	Water Content, w_o 46.9 %	w_f 37.3 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o 1.33	e_f 0.98
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o 94 %	S_f 100 %
Compression Index, C_c		Dry Density, γ_d 71.6 lb/ft^3	
Classification Fat clay, CH		k_{20} at e_o = x 10^{-} cm/sec	
LL 69	G_s 2.67	Project CHASKA; NCS-IA-89-09-ED-GH	
PL 24	D_{10}		

Remarks Gray with rust spots, non-calcareous. Torvane=0.4 TSF.	Area	MRD LAB NO. 89/177	
	Boring No.	88-103 MU	Sample No. 1
	Depth El	6'-8'	Date

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

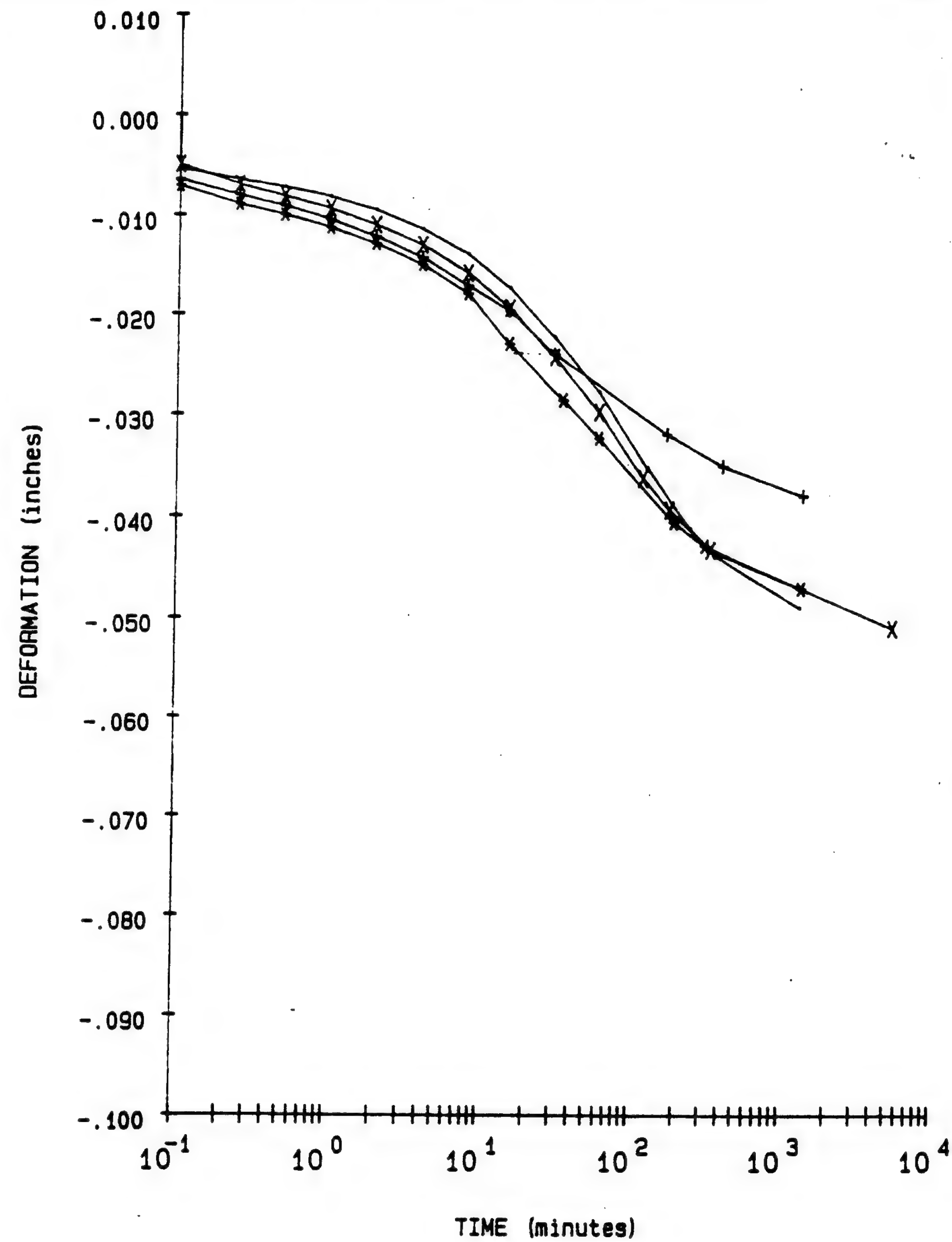
Figure 19



LEGEND	
+ =	.1 TSF
* =	.25 TSF
X =	.5 TSF

PROJECT	CHASKA; NCS-IA-89-09-ED-6H
BORING NO.	88-103 MU
SAMPLE NO.	1
DEPTH/ELEV	6'-8'
MRD LAB NO.	89/177

FIGURE 20

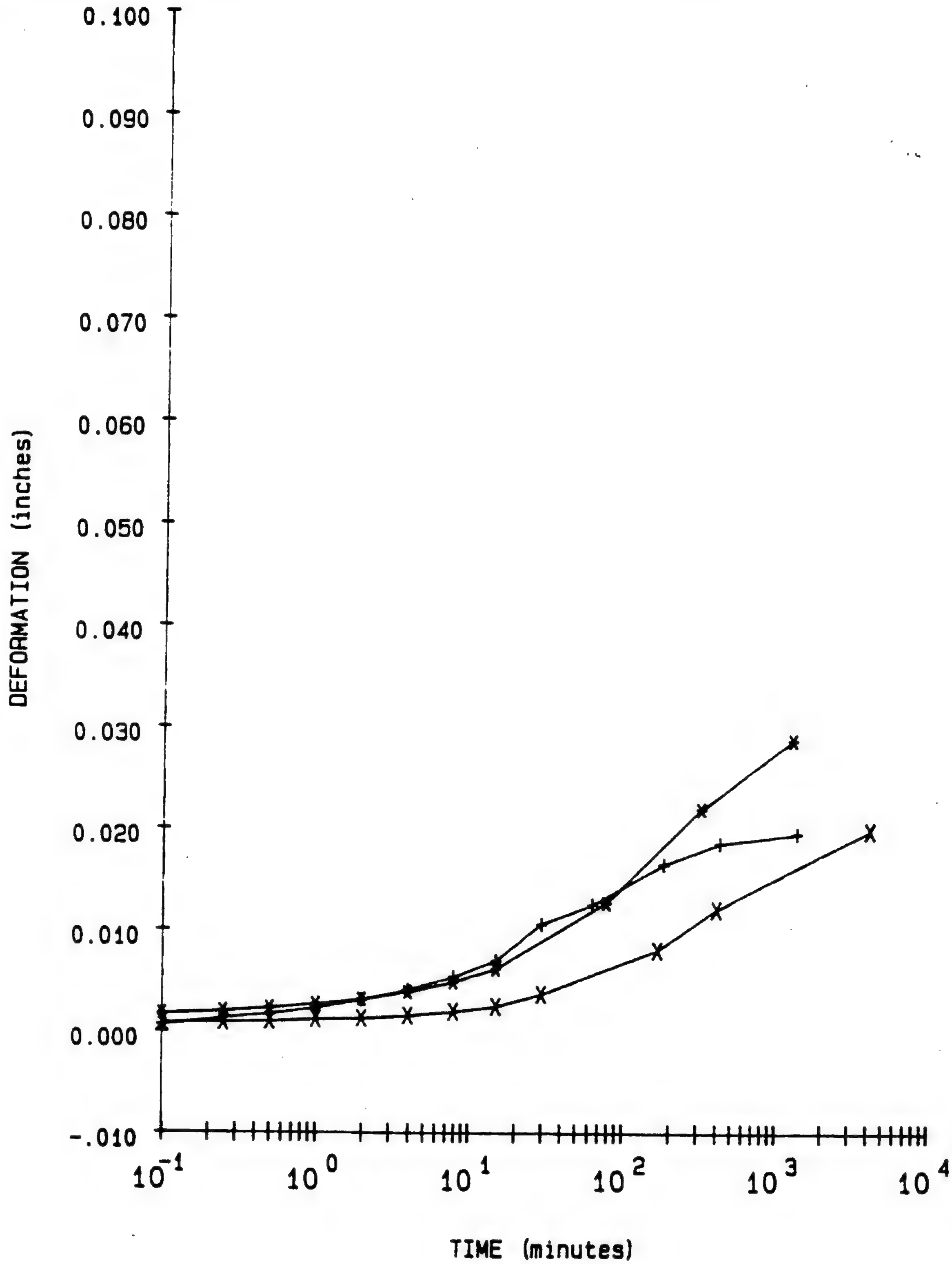


LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF
- = 8 TSF

PROJECT	CHASKA: NCS-IA-89-09-ED-8H
BORING NO.	88-103 MU
SAMPLE NO.	1
DEPTH/ELEV	6'-8'
MRD LAB NO.	89/177

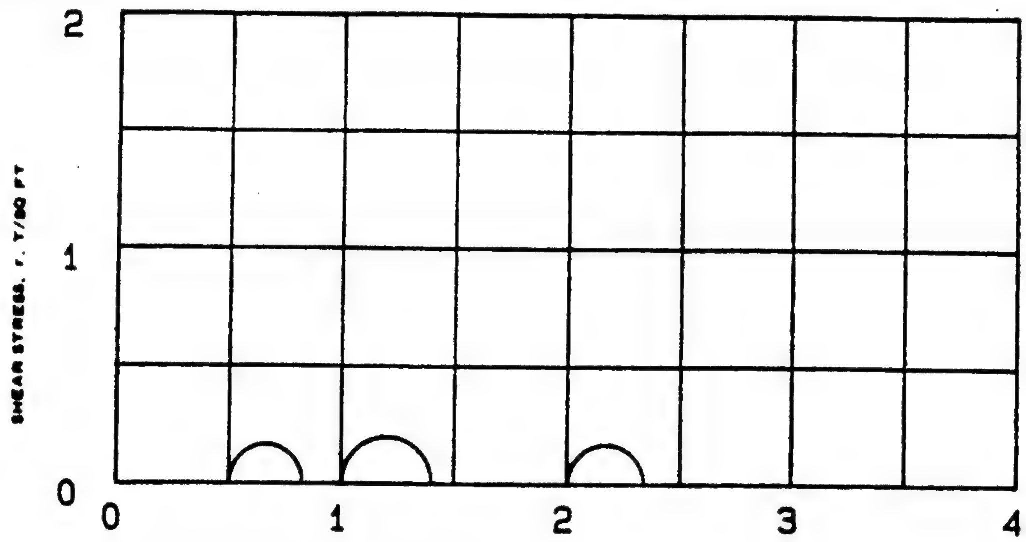
FIGURE 21



LEGEND		
+ = 2	TSF	Rebound
* = .5	TSF	Rebound
X = .1	TSF	Rebound

PROJECT	CHASKA: NCS-IA-89-09-ED-GH
BORING NO.	88-103 MU
SAMPLE NO.	1
DEPTH/ELEV	6'-8'
MRD LAB NO.	89/177

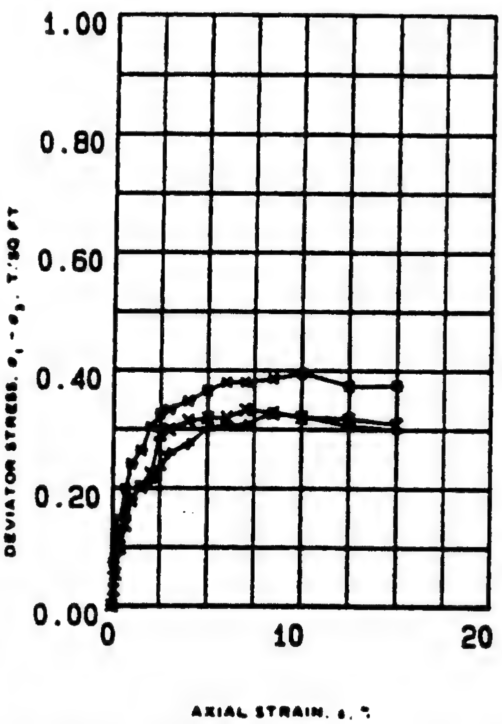
FIGURE 22



Q-1

Q-2

Q-3



SPECIMEN NO.			1 (+)	2 (✱)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	46.7	45.3	47.1	
	DRY DENSITY LB/CU FT	γd_o	75.5	75.9	73.5	
	SATURATION, %	S_o	100.0	100.0	99.0	
	VOID RATIO	e_o	1.21	1.20	1.27	
BEFORE SHEAR	WATER CONTENT, %	w_c	46.5	45.1	47.4	
	DRY DENSITY LB/CU FT	γd_c	75.5	75.9	73.5	
	SATURATION, %	S_c	100.0	100.0	100.0	
	VOID RATIO	e_c	1.21	1.20	1.27	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.33	0.40	0.33	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	14.5	18.0	11.5	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.30	0.38	0.31	
INITIAL DIAMETER, IN		D_o	1.40	1.40	1.40	
INITIAL HEIGHT, IN		H_o	2.99	3.00	2.99	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH

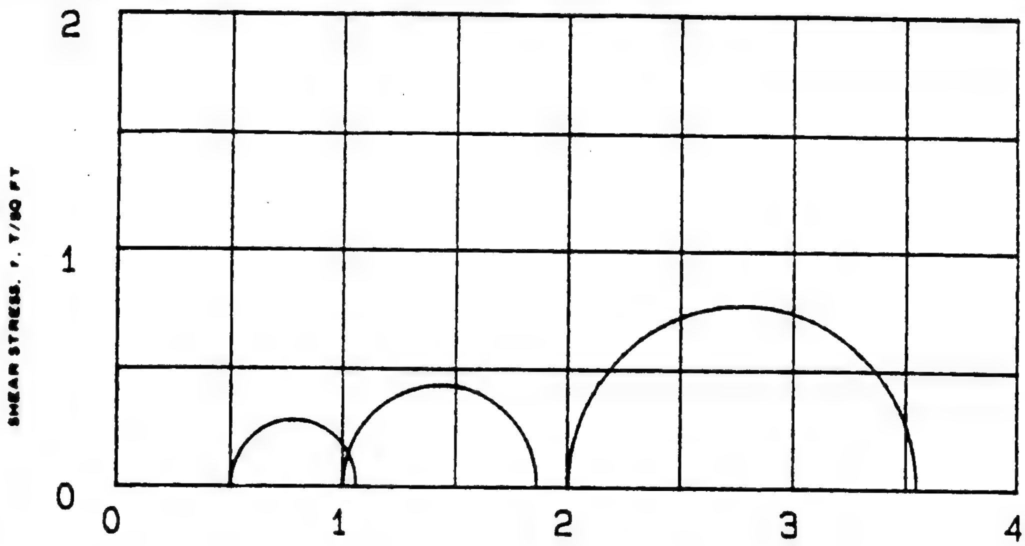
LL 69	PL 24	PI 45	Gs 2.67	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

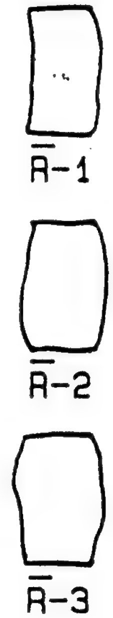
REMARKS: Gray with rust spots, non-calcareous. Torvane=.4 TSF.

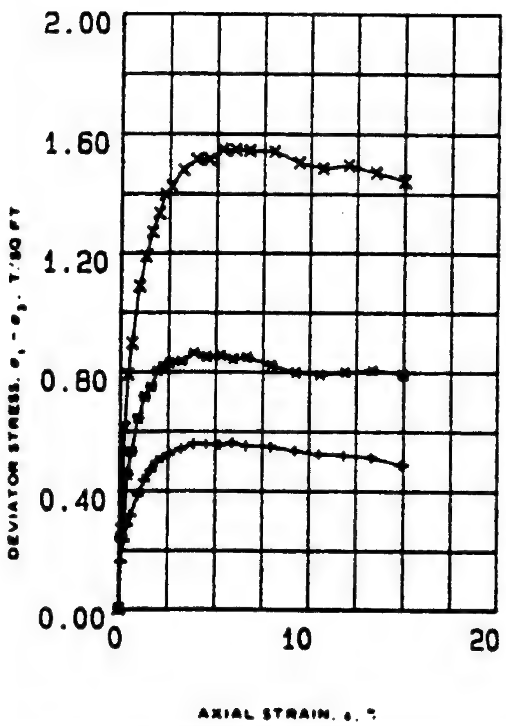
PROJECT	CHASKA: NCS-IA-88-09-ED-SH
BORING NO	88-103 MU
SAMPLE NO.	1
DEPTH ELEV	6'-8'
LABORATORY	88/177
DATE	

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 23







SPECIMEN NO.			1 (+)	2 (✻)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	49.7	50.1	49.3	
	DRY DENSITY LB/CU FT	γ_{d_o}	69.9	71.2	69.1	
	SATURATION, %	S_o	96	100	93	
	VOID RATIO	e_o	1.38	1.34	1.41	
BEFORE SHEAR	WATER CONTENT, %	w_c	48.8	46.7	43.8	
	DRY DENSITY LB/CU FT	γ_{d_c}	72.5	74.6	75.4	
	SATURATION, %	S_c	100	100	97	
	VOID RATIO	e_c	1.3	1.23	1.21	
	FINAL BACK PRESSURE, T/SQ FT	u_o	2.863	2.863	2.863	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.561	0.864	1.548	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	540	360	480	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.487	0.791	1.444	
INITIAL DIAMETER, IN		D_o	1.4	1.4	1.41	
INITIAL HEIGHT, IN		H_o	3	3	3.01	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH B-Value 1.0 1.0 1.0

LL 69 | PL 24 | PI 45 | G_s 2.87

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST RBAR

REMARKS: Gray with rust spots, non-calcareous. Torvane=0.4 TSF.

PROJECT CHASKA; NCS-IA-88-09-ED-SH

BORING NO 88-103 MU | SAMPLE NO. 1

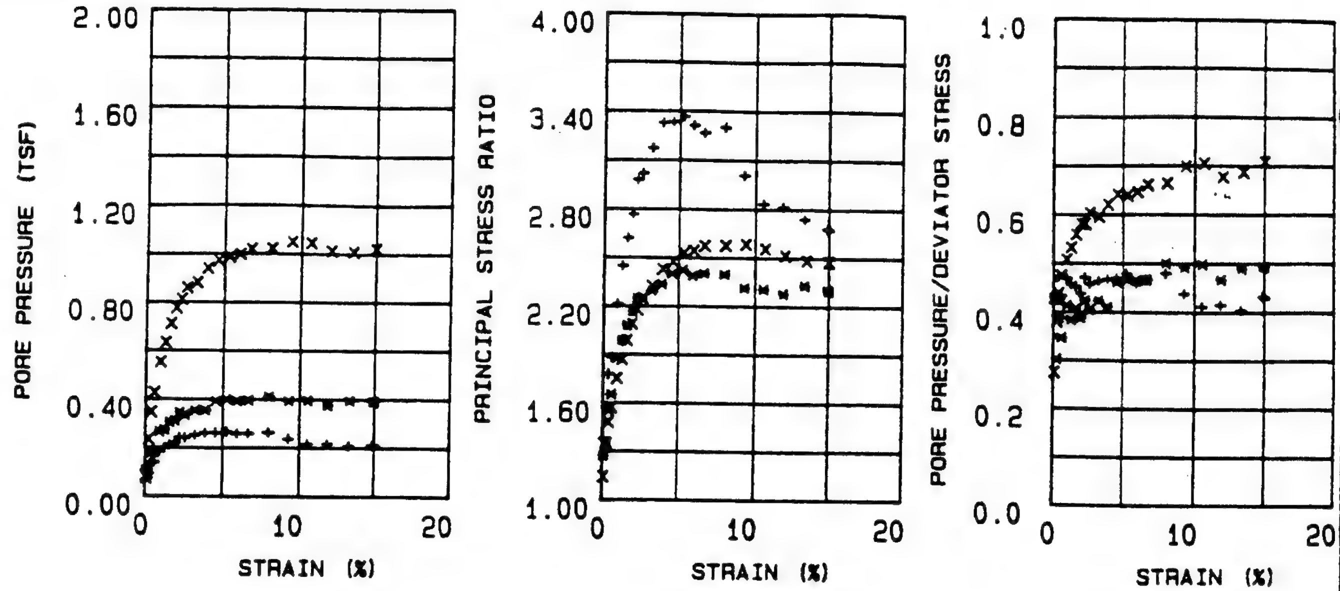
DEPTH ELEV 6'-8'

LABORATORY 89/177 | DATE

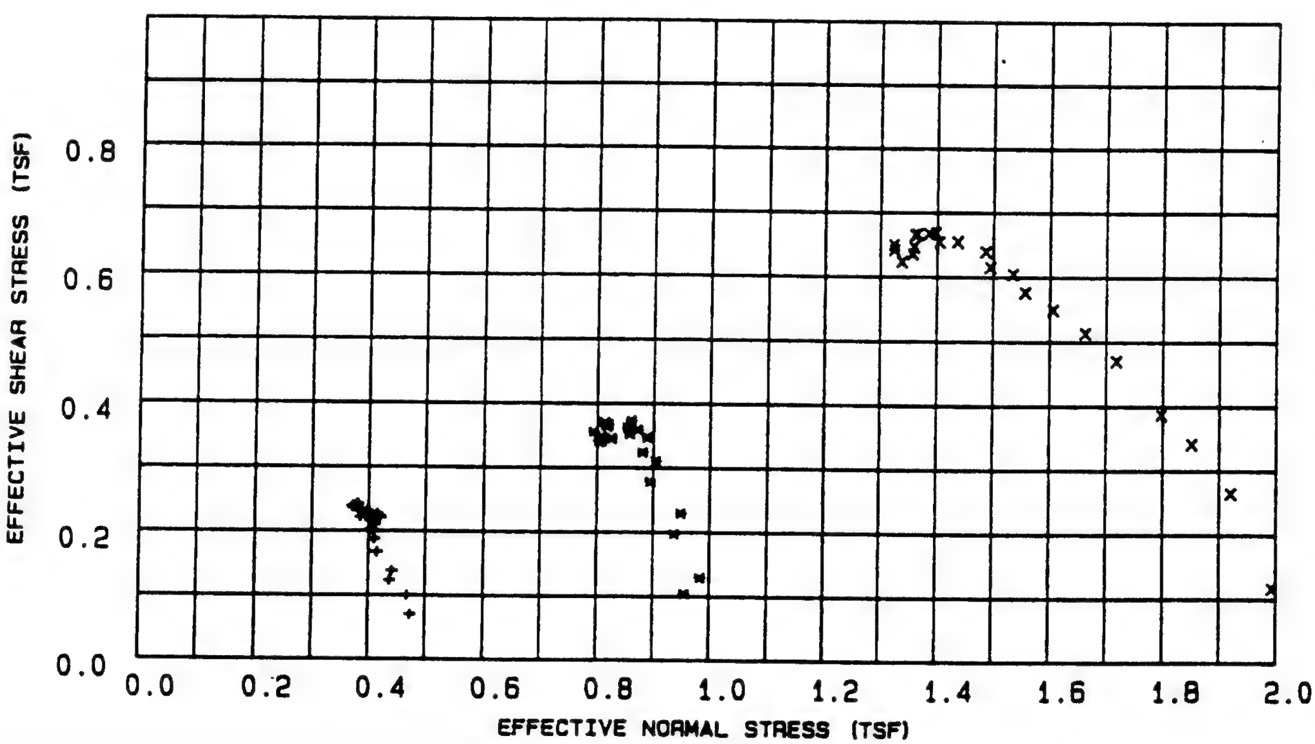
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 11



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF

✱ = 1 TSF

X = 2 TSF

PROJECT	CHASKA: NCS-IA-88-09-ED-GH
BORING NO.	88-103 MU
SAMPLE NO.	1
DEPTH/ELEV	6'-8'
MRD LAB NO.	89/177

FIGURE 12

Table 7 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; NCS-IA-88-09-ED-GH
Boring Number : 88-103 MU
Sample Number : 1
Depth : 6'-8'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.09	0.162	0.067	1.374	0.416	0.473	0.070
30	0.26	0.232	0.091	1.568	0.390	0.467	0.100
45	0.40	0.285	0.134	1.780	0.472	0.437	0.123
60	0.59	0.319	0.138	1.880	0.432	0.441	0.138
90	0.95	0.387	0.181	2.213	0.469	0.415	0.167
120	1.26	0.437	0.198	2.447	0.455	0.410	0.188
150	1.59	0.468	0.211	2.619	0.452	0.405	0.202
180	1.92	0.499	0.218	2.766	0.437	0.405	0.215
210	2.23	0.512	0.241	2.977	0.471	0.386	0.221
240	2.57	0.525	0.240	3.019	0.457	0.390	0.227
300	3.21	0.542	0.251	3.173	0.463	0.383	0.234
360	3.87	0.558	0.260	3.328	0.467	0.378	0.241
420	4.54	0.557	0.261	3.332	0.470	0.377	0.240
480	5.25	0.554	0.266	3.365	0.479	0.371	0.239
540	5.91	0.561	0.257	3.310	0.458	0.382	0.242
600	6.62	0.550	0.257	3.265	0.467	0.379	0.238
720	7.96	0.547	0.262	3.299	0.480	0.373	0.236
840	9.26	0.534	0.234	3.006	0.437	0.398	0.231
960	10.54	0.523	0.214	2.830	0.411	0.415	0.226
1080	11.87	0.518	0.214	2.813	0.414	0.414	0.224
1200	13.32	0.511	0.206	2.737	0.403	0.421	0.221
1320	14.87	0.487	0.210	2.679	0.432	0.410	0.210
1330	15.00	0.487	0.209	2.671	0.429	0.411	0.210

Table 8 - Triaxial $\bar{R}$ Test Results

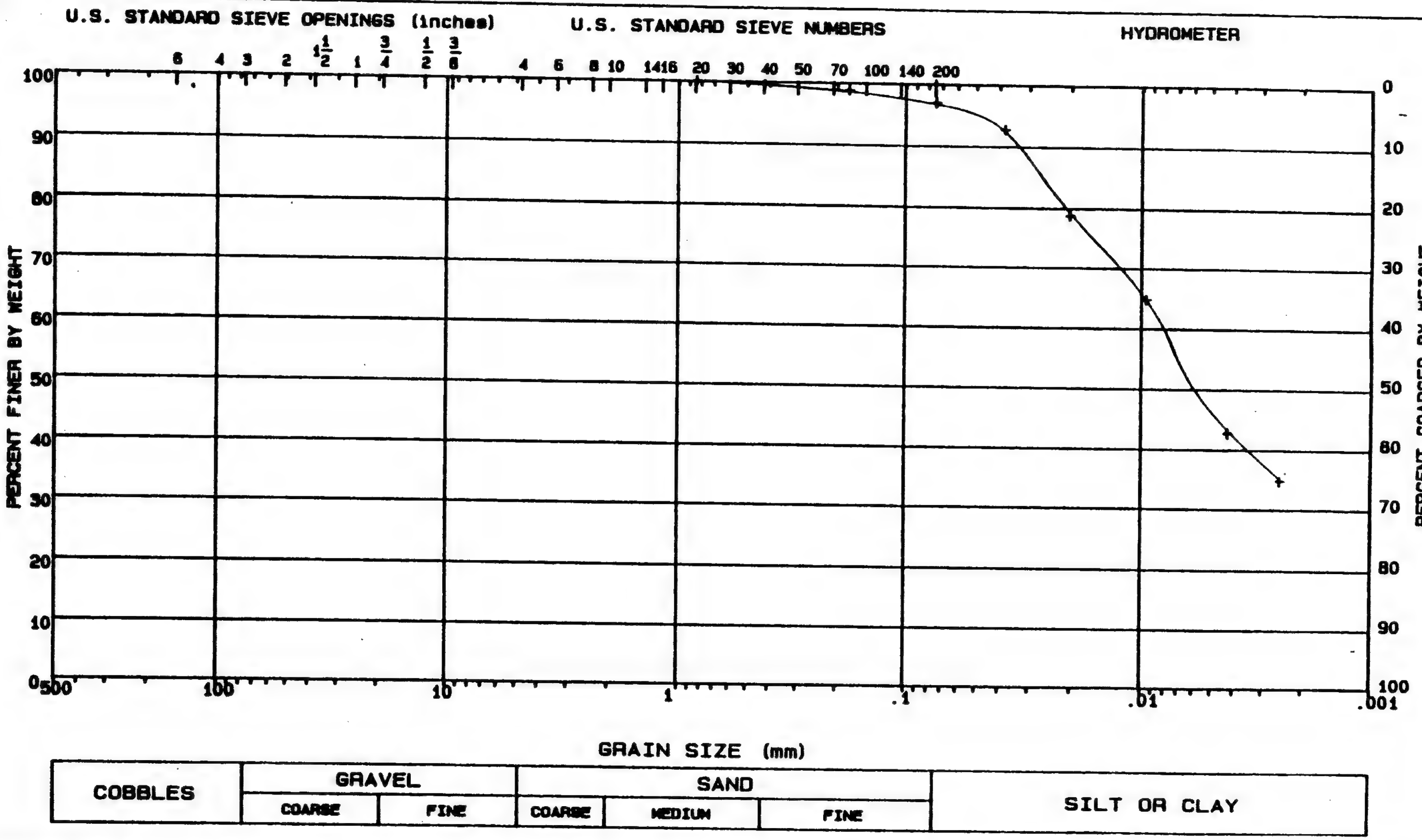
Project : CHASKA; NCS-IA-88-09-ED-GH
Boring Number : 88-103 MU
Sample Number : 1
Depth : 6'-8'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.09	0.242	0.104	1.269	0.429	0.956	0.104
30	0.26	0.293	0.090	1.328	0.301	0.984	0.129
45	0.40	0.455	0.176	1.553	0.387	0.937	0.197
60	0.60	0.532	0.183	1.651	0.345	0.949	0.229
90	0.95	0.644	0.266	1.878	0.413	0.894	0.278
120	1.26	0.718	0.274	1.989	0.383	0.904	0.310
150	1.60	0.751	0.306	2.082	0.407	0.880	0.324
180	1.93	0.804	0.311	2.166	0.387	0.888	0.[illegible]
210	2.24	0.818	0.345	2.249	0.423	0.857	0.353
240	2.57	0.831	0.335	2.249	0.404	0.871	0.359
300	3.22	0.838	0.354	2.297	0.423	0.853	0.362
360	3.88	0.864	0.354	2.337	0.410	0.860	0.373
420	4.55	0.851	0.392	2.400	0.461	0.819	0.367
480	5.27	0.856	0.399	2.424	0.466	0.813	0.370
540	5.93	0.844	0.392	2.387	0.465	0.817	0.364
600	6.65	0.849	0.395	2.403	0.466	0.815	0.366
720	7.98	0.823	0.411	2.397	0.500	0.793	0.355
840	9.29	0.798	0.392	2.312	0.492	0.805	0.344
960	10.58	0.791	0.394	2.304	0.498	0.802	0.341
1080	11.91	0.800	0.373	2.276	0.466	0.825	0.[illegible]
1200	13.37	0.806	0.394	2.330	0.489	0.806	0.348
1320	14.92	0.793	0.390	2.300	0.493	0.806	0.342
1326	15.00	0.791	0.390	2.296	0.493	0.806	0.341

Table 9 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; NCS-IA-88-09-ED-GH
Boring Number : 88-103 MU
Sample Number : 1
Depth : 6'-8'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.269	0.074	1.140	0.274	1.993	0.116
30	0.26	0.612	0.232	1.346	0.379	1.920	0.264
45	0.41	0.791	0.345	1.478	0.437	1.851	0.341
60	0.60	0.896	0.425	1.569	0.474	1.797	0.387
90	0.96	1.088	0.551	1.751	0.507	1.718	0.470
120	1.27	1.189	0.632	1.869	0.532	1.662	0.513
150	1.61	1.271	0.710	1.986	0.559	1.605	0.549
180	1.95	1.335	0.774	2.089	0.581	1.557	0.576
210	2.26	1.399	0.811	2.177	0.581	1.535	0.604
240	2.60	1.426	0.859	2.249	0.603	1.494	0.615
300	3.25	1.480	0.880	2.322	0.595	1.486	0.639
360	3.92	1.515	0.939	2.428	0.620	1.436	0.654
420	4.60	1.515	0.971	2.472	0.641	1.404	0.654
480	5.32	1.548	0.986	2.526	0.638	1.397	0.668
540	5.99	1.547	0.998	2.544	0.646	1.385	0.667
600	6.71	1.544	1.018	2.573	0.660	1.364	0.666
720	8.06	1.541	1.021	2.574	0.663	1.360	0.665
840	9.38	1.504	1.049	2.582	0.698	1.323	0.649
960	10.68	1.485	1.044	2.554	0.704	1.324	0.641
1080	12.03	1.496	1.011	2.512	0.676	1.359	0.646
1200	13.50	1.471	1.008	2.482	0.686	1.356	0.635
1315	15.00	1.444	1.021	2.474	0.708	1.337	0.623
1315	15.00	1.444	1.021	2.474	0.708	1.337	0.623



LL - 69 | PL - 24 | PI - 45 | Gs - 2.67 | NAT w - %

CLASSIFICATION Fat clay, CH

Classification tests performed on trimmings from Q test.

GRADATION CURVE

PROJECT CHASKA; NCS-IA-89-09-ED-GH

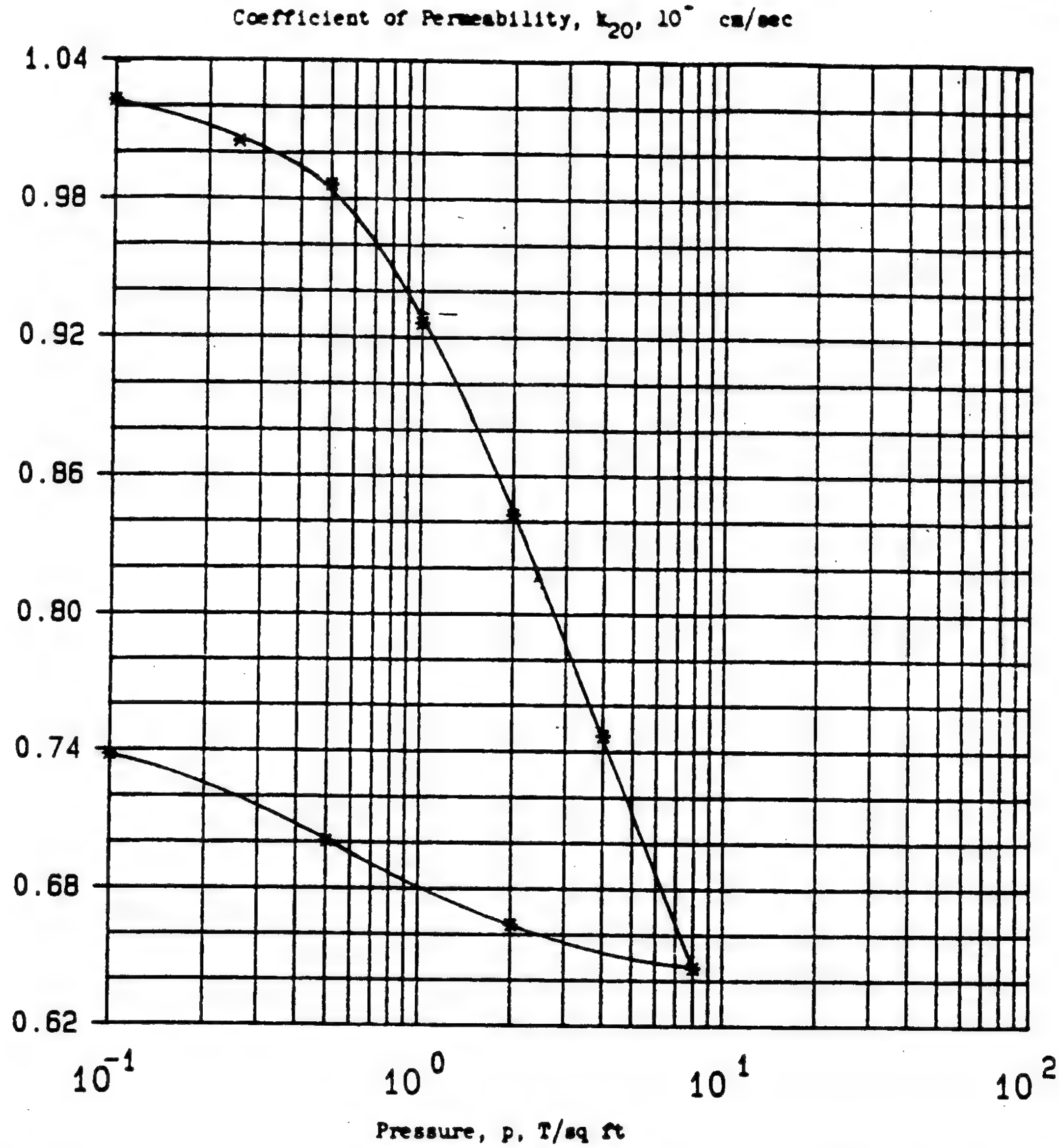
BORING NO. 88-103 MU

SAMPLE NO. 1

DEPTH/ELEV 6'-8'

MRD LAB NO. 89/177

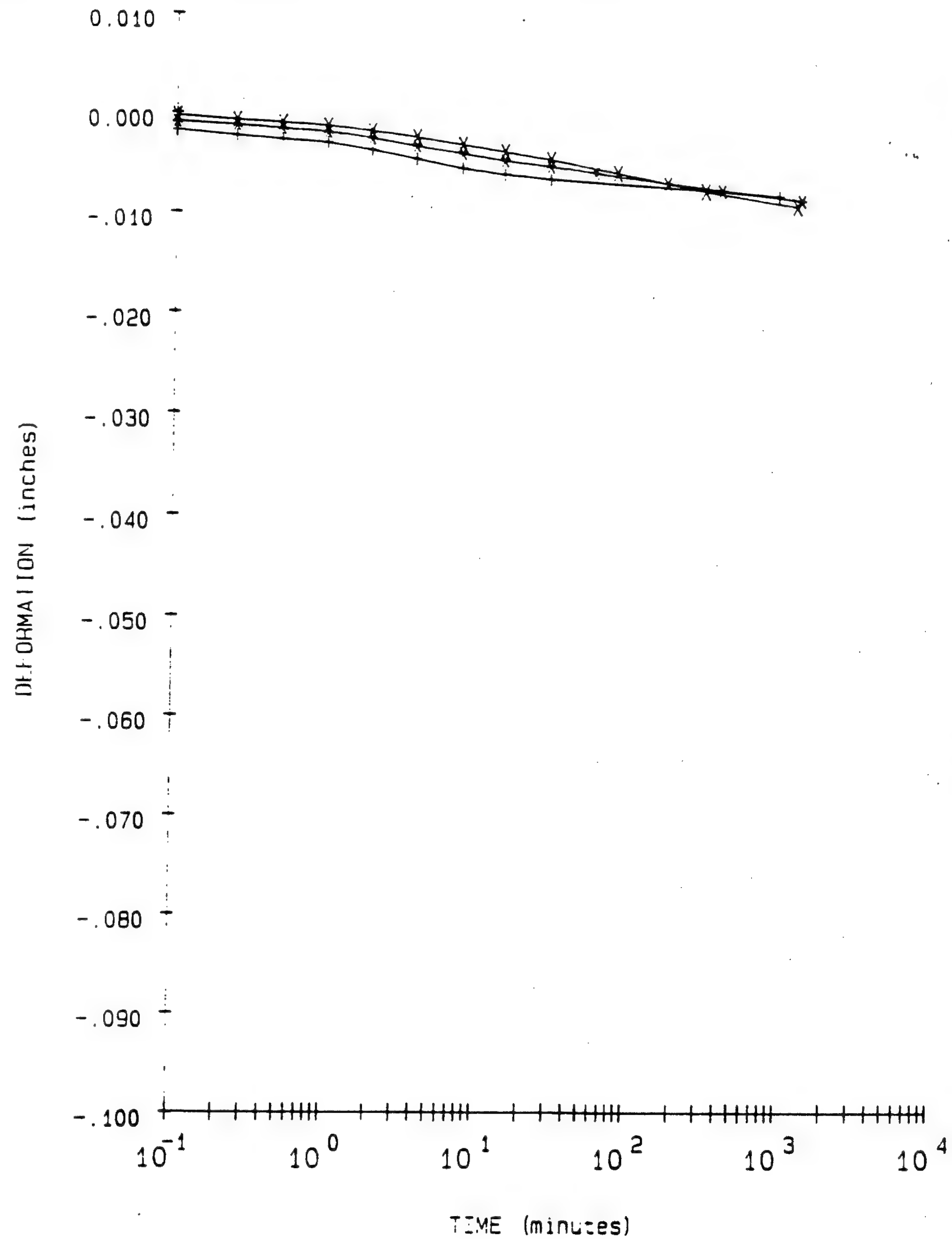
FIGURE 24



Type of Specimen	UNDISTURBED		Before Test		After Test	
Diam 4.3 in.	Ht 1 in.		Water Content, w_o	33.0 %	w_f	32.5 %
Overburden Pressure, p_o	T/sq ft		Void Ratio, e_o	1.04	e_f	0.74
Preconsol. Pressure, p_c	T/sq ft		Saturation, S_o	85 %	S_f	100 %
Compression Index, C_c			Dry Density, γ_d	82.3 lb/ft^3		
Classification Fat clay, CH			k_{20} at e_o =	$\times 10^{-}$ cm/sec		
LL 56	G_s 2.69		Project	CHASKA; NCS-IA-89-09-ED-GN		
PL 23	D_{10}					
Remarks Mottled gray and brown,			Area	MRD LAB NO. 89-177		
calcareous. Torvane=0.4 TSF.			Boring No. 88-103 MU		Sample No. 3	
			Depth El 16'-18'		Date	
			CONSOLIDATION TEST REPORT			

ENG FORM 2090 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 13



LEGEND

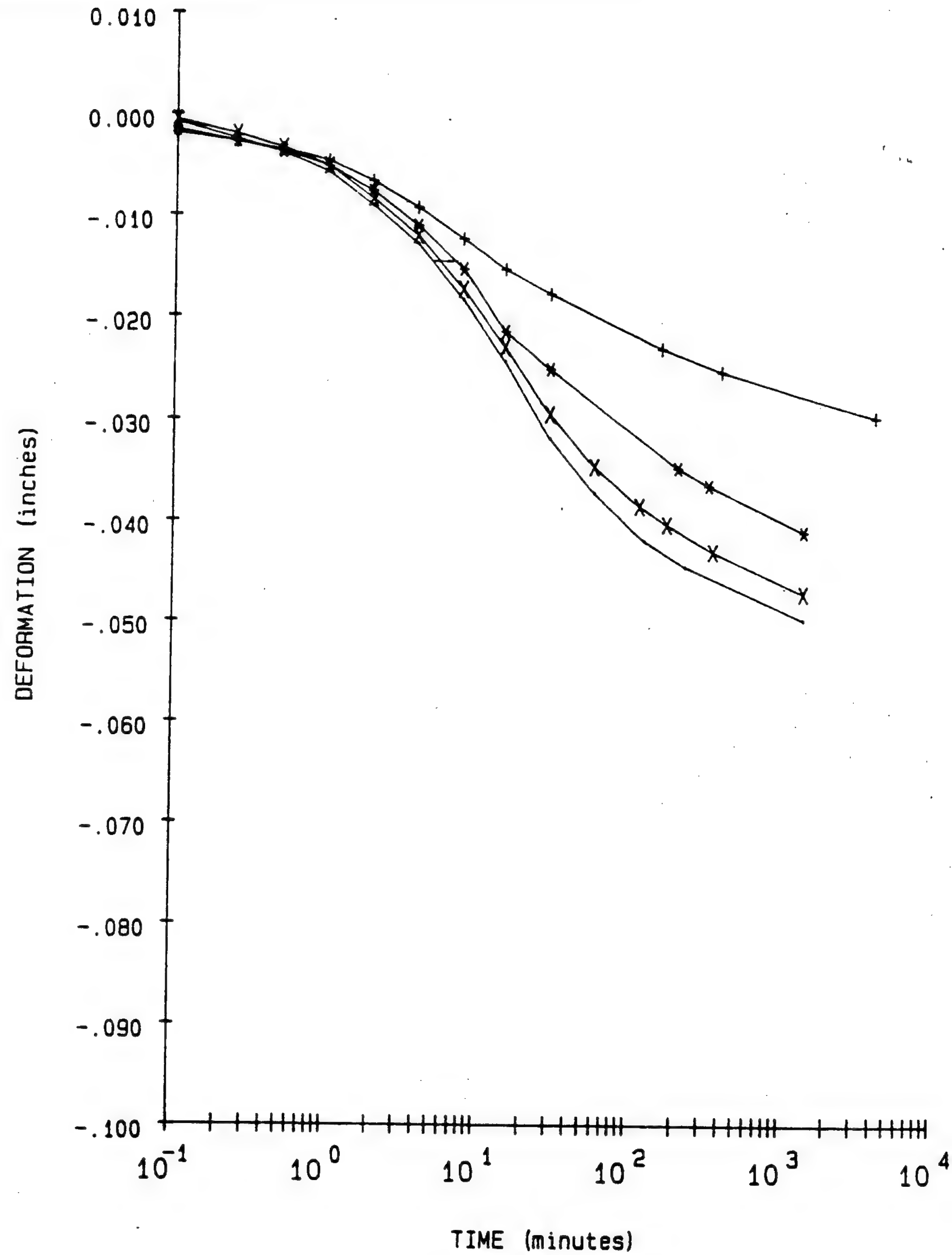
+ = .1 TSF

* = .25 TSF

X = .5 TSF

PROJECT	CHASKA; NCS-IA-89-09-ED-GN
BORING NO.	88-103 MU
SAMPLE NO.	3
DEPTH/ELEV	16'-18'
MRD LAB NO.	89-177

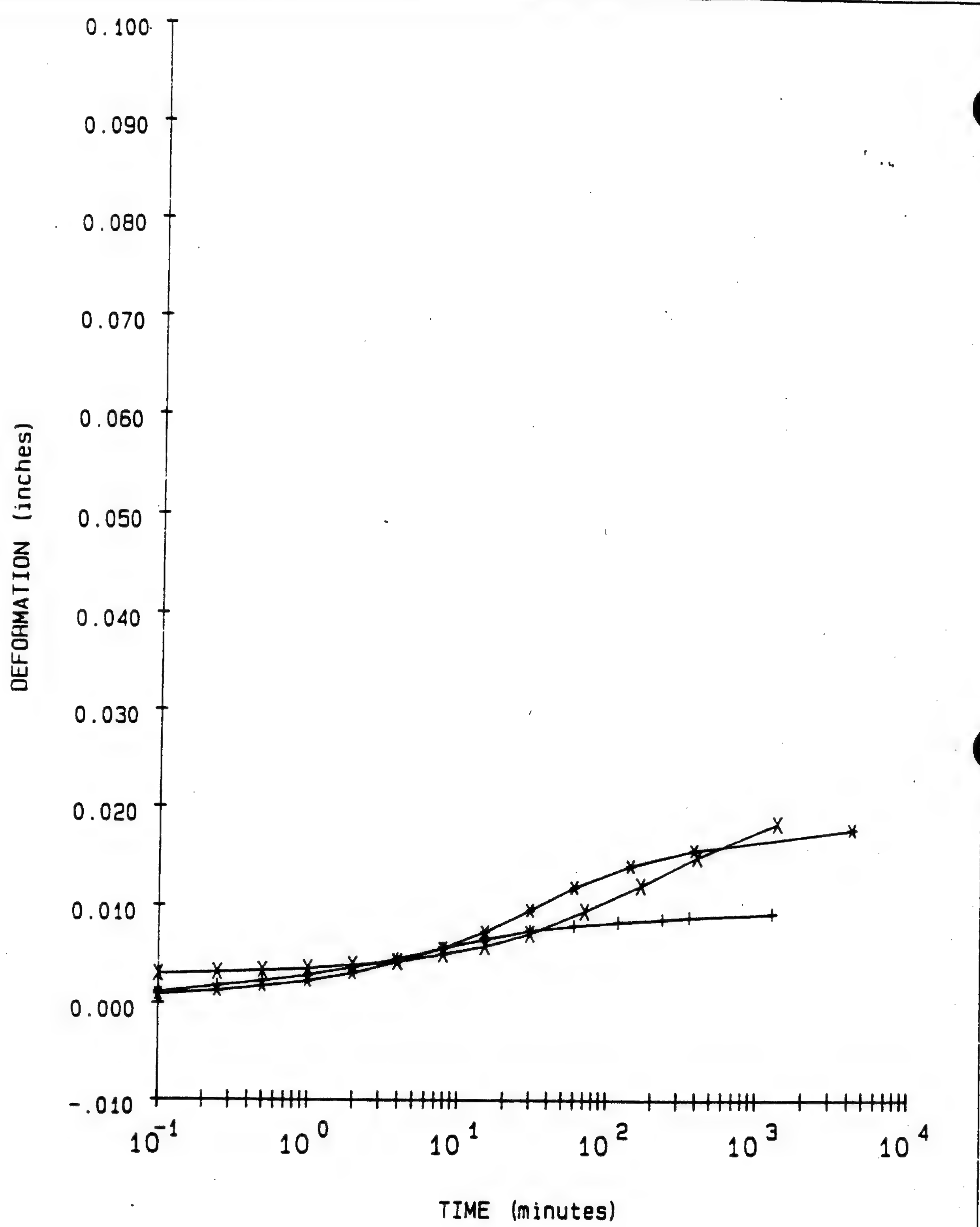
FIGURE 14



LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	CHASKA; NCS-IA-89-09-ED-GN
BORING NO.	88-103 MU
SAMPLE NO.	3
DEPTH/ELEV	16'-18'
MRD LAB NO.	89-177

FIGURE 15



LEGEND

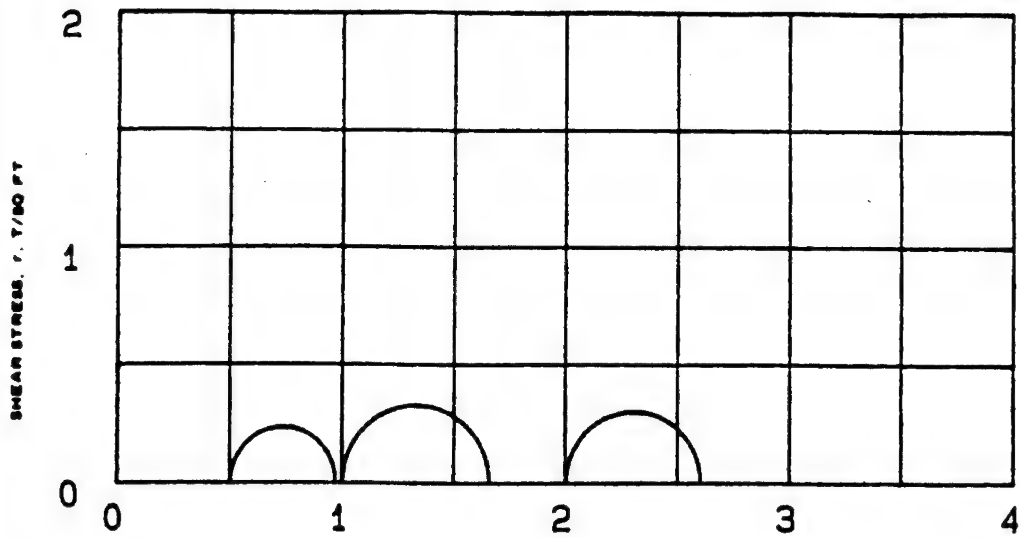
+ = 2 TSF Rebound

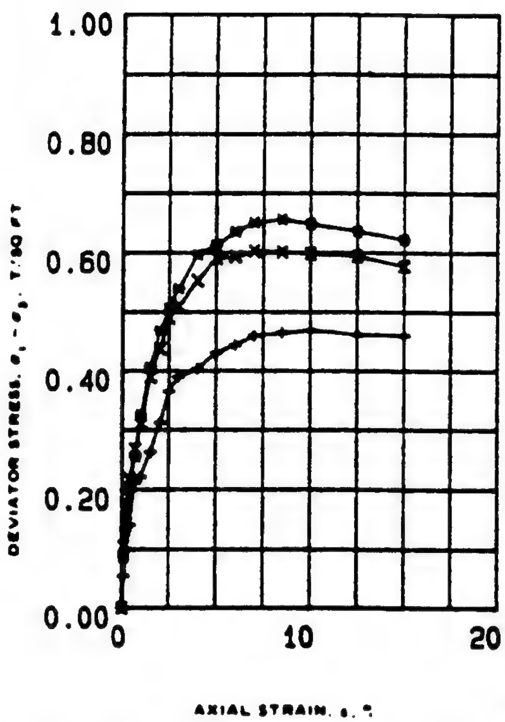
* = .5 TSF Rebound

X = .1 TSF Rebound

PROJECT	CHASKA; NCS-IA-89-09-ED-GN
BORING NO.	88-103 MU
SAMPLE NO.	3
DEPTH/ELEV	16'-18'
MRD LAB NO.	89-177

FIGURE 16





SPECIMEN NO.			1 (+)	2 (✱)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	40.1	39.2	39.8	
	DRY DENSITY LB/CU FT	γd_o	81.4	83.1	82.4	
	SATURATION, %	s_o	100.0	100.0	100.0	
	VOID RATIO	e_o	1.06	1.02	1.04	
BEFORE SHEAR	WATER CONTENT, %	w_c	39.9	39.0	39.7	
	DRY DENSITY LB/CU FT	γd_c	81.4	83.1	82.4	
	SATURATION, %	s_c	100.0	100.0	100.0	
	VOID RATIO	e_c	1.06	1.02	1.04	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.47	0.66	0.60	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	21.8	16.5	13.8	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.46	0.62	0.58	
INITIAL DIAMETER, IN.		D_o	1.40	1.41	1.41	
INITIAL HEIGHT, IN.		H_o	3.00	2.99	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH

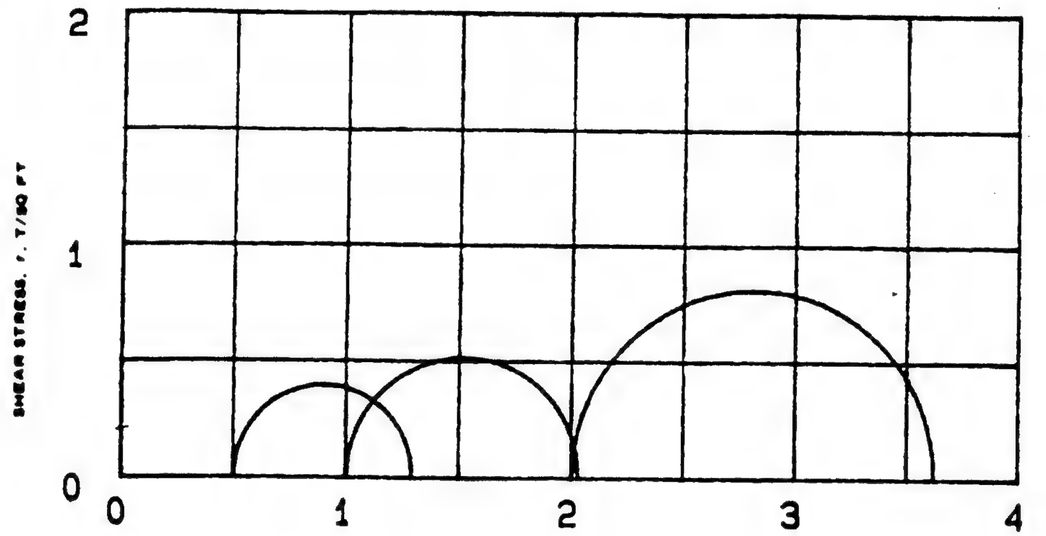
LL 56	PL 23	PI 33	G: 2.69 Est.	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

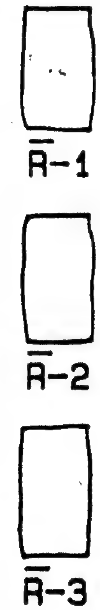
REMARKS: Gray with some brown, calcareous. Torvane=0.4 TSF.

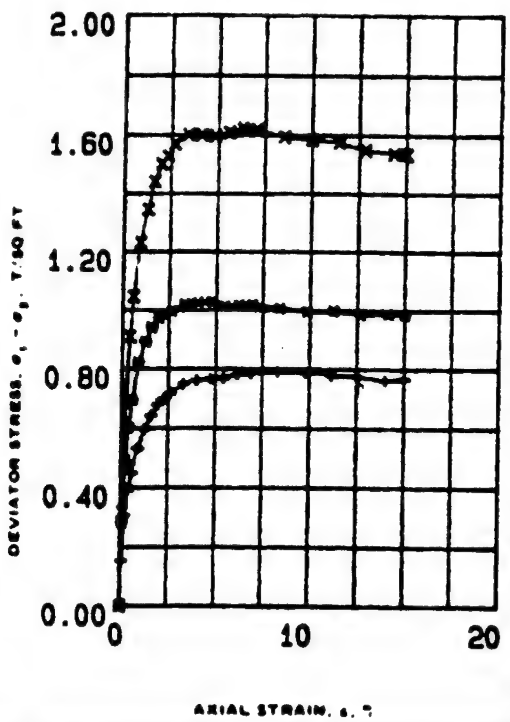
PROJECT	CHASKA; NCS-IA-89-09-ED-SH
BORING NO	89-103 MU
SAMPLE NO.	3
DEPTH ELEV	16'-18'
LABORATORY	89/177
DATE	

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 25





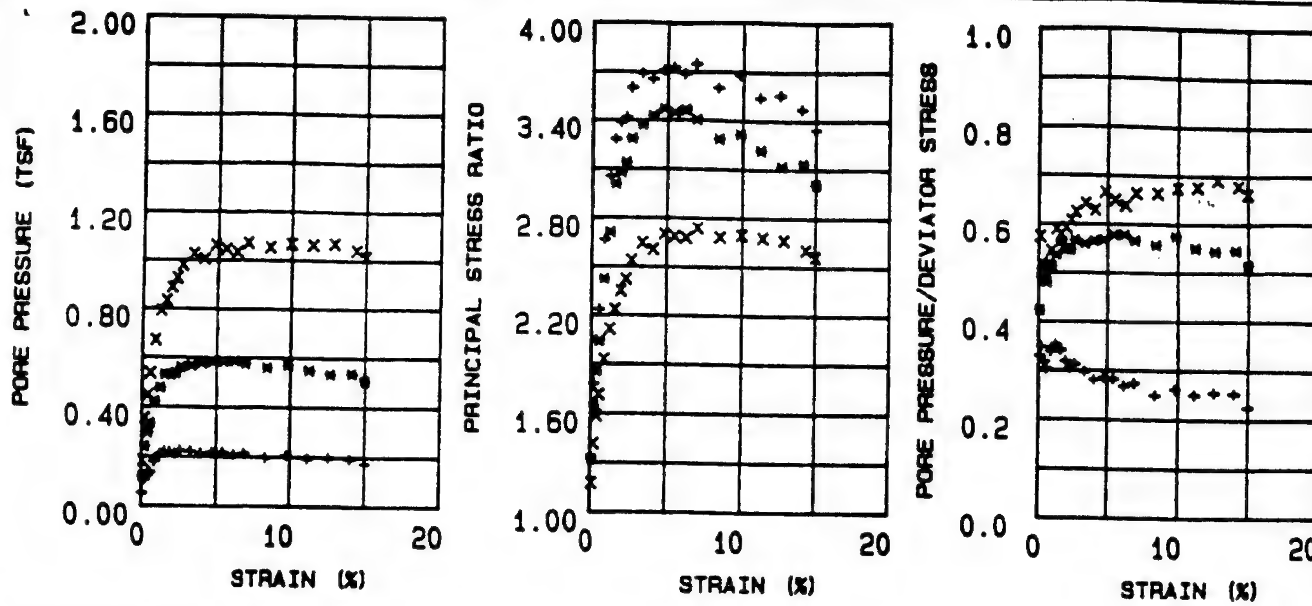


SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	43	40.4	41.8	
	DRY DENSITY LB/CU FT	γ_{d_o}	78.1	79.2	78	
	SATURATION, %	S_o	100	97	97	
	VOID RATIO	e_o	1.15	1.12	1.15	
BEFORE SHEAR	WATER CONTENT, %	w_c	38.4	36.7	36.2	
	DRY DENSITY LB/CU FT	γ_{d_c}	78.3	82.2	84	
	SATURATION, %	S_c	90	95	97	
	VOID RATIO	e_c	1.14	1.04	1	
	FINAL BACK PRESSURE, T/SQ FT	u_o	3.383	3.383	3.383	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.79	1.028	1.622	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	720	420	540	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.767	.988	1.536	
INITIAL DIAMETER, IN.		D_o	1.42	1.41	1.42	
INITIAL HEIGHT, IN.		H_o	2.99	3	2.99	
B-Value			1.0	1.0	1.0	

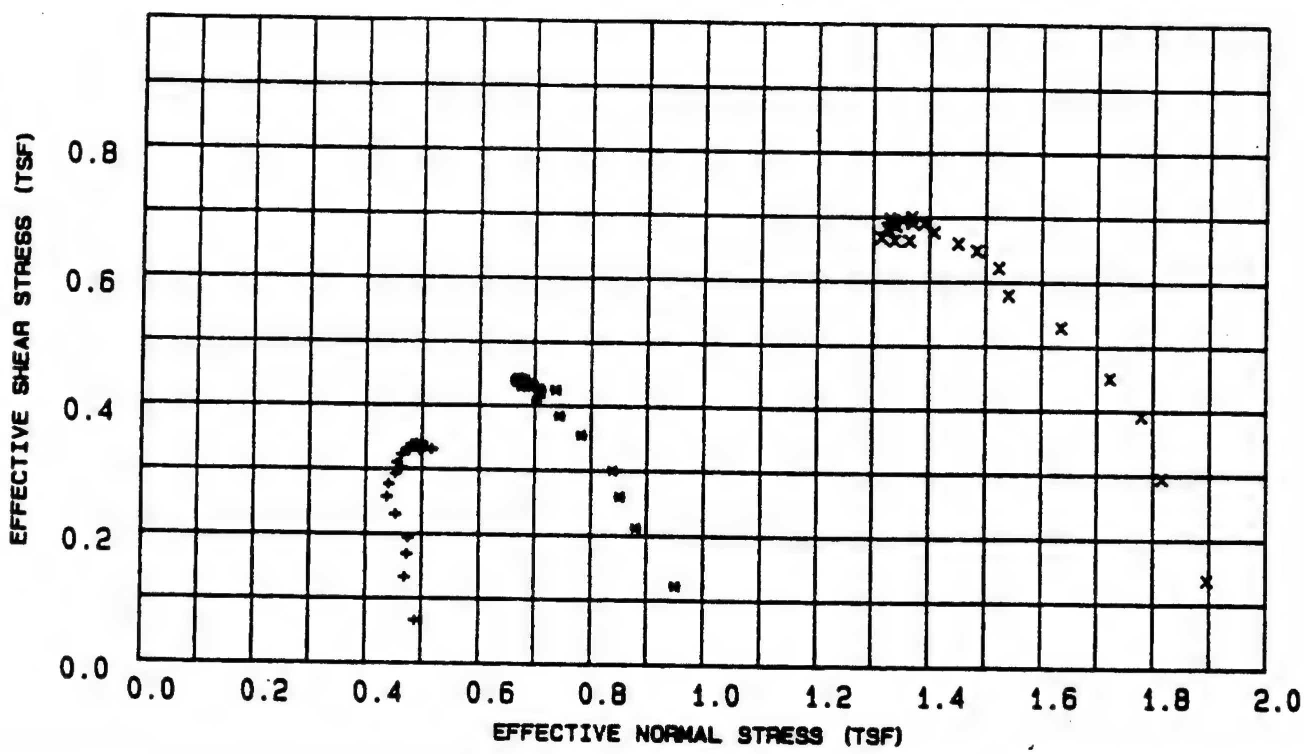
CONTROLLED- STRAIN TEST					
DESCRIPTION OF SPECIMENS Fat clay, CH					
LL 56	PL 23	PI 33	G_s 2.80	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR
REMARKS: Gray with some brown, calcareous. Torvane=0.4 TSF.				PROJECT CHASKA: NCS-IA-88-09-ED-SH	
				BORING NO 88-103 MU	SAMPLE NO. 3
				DEPTH ELEV 15'-18'	
				LABORATORY 88/177	DATE
				TRIAXIAL COMPRESSION TEST REPORT	

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 26



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF
✱ = 1 TSF
X = 2 TSF

PROJECT	CHASKA; NCS-IA-89-09-ED-6H
BORING NO.	88-103 MU
SAMPLE NO.	3
DEPTH/ELEV	16'-18'
MRD LAB NO.	89/177

FIGURE 27

Table 7 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; NCS-IA-89-09-ED-GH
Boring Number : 88-103 MU
Sample Number : 3
Depth : 16'-18'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.09	0.153	0.050	1.339	0.329	0.488	0.066
30	0.23	0.307	0.107	1.781	0.348	0.469	0.133
45	0.42	0.392	0.124	2.041	0.317	0.473	0.169
60	0.59	0.450	0.136	2.235	0.302	0.475	0.194
90	0.90	0.532	0.180	2.664	0.339	0.452	0.230
120	1.25	0.596	0.210	3.055	0.353	0.437	0.257
150	1.58	0.642	0.219	3.282	0.341	0.440	0.277
180	1.93	0.679	0.216	3.386	0.318	0.452	0.2[illegible]3
210	2.26	0.699	0.211	3.421	0.303	0.462	0.302
240	2.62	0.718	0.224	3.604	0.312	0.454	0.310
300	3.32	0.749	0.222	3.692	0.297	0.463	0.323
360	4.01	0.762	0.213	3.658	0.281	0.476	0.329
420	4.71	0.766	0.218	3.713	0.285	0.472	0.331
480	5.42	0.770	0.218	3.728	0.283	0.473	0.332
540	6.15	0.782	0.209	3.687	0.268	0.485	0.337
600	6.88	0.785	0.214	3.748	0.274	0.480	0.339
720	8.34	0.790	0.196	3.602	0.249	0.500	0.341
840	9.76	0.788	0.206	3.679	0.262	0.489	0.340
960	11.15	0.778	0.194	3.542	0.250	0.498	0.336
1080	12.54	0.774	0.197	3.559	0.255	0.495	0.[illegible]
1200	14.00	0.762	0.192	3.474	0.253	0.497	0.329
1277	15.00	0.767	0.173	3.348	0.226	0.517	0.331

Table 8 - Triaxial $\bar{R}$ Test Results

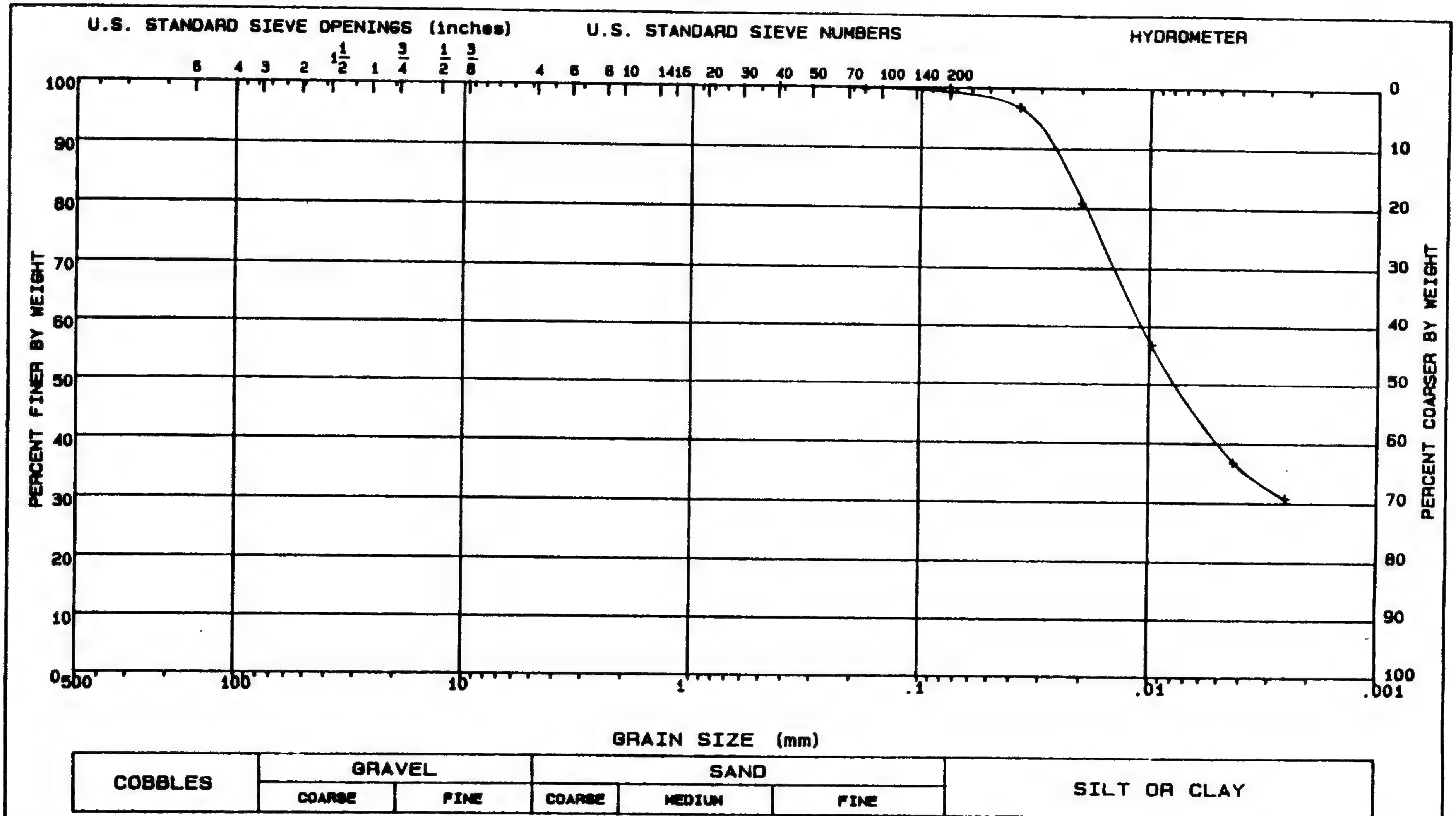
Project : CHASKA; NCS-IA-89-09-ED-GH
Boring Number : 88-103 MU
Sample Number : 3
Depth : 16'-18'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.09	0.282	0.119	1.320	0.423	0.951	0.122
30	0.24	0.491	0.240	1.645	0.490	0.881	0.212
45	0.43	0.602	0.297	1.856	0.493	0.852	0.260
60	0.59	0.695	0.333	2.042	0.480	0.839	0.300
90	0.90	0.822	0.422	2.422	0.513	0.782	0.355
120	1.26	0.892	0.478	2.710	0.537	0.743	0.385
150	1.59	0.942	0.531	3.008	0.564	0.702	0.407
180	1.95	0.973	0.532	3.080	0.548	0.709	0.420
210	2.28	0.985	0.540	3.140	0.548	0.704	0.425
240	2.64	0.997	0.564	3.288	0.567	0.683	0.430
300	3.35	1.020	0.570	3.372	0.560	0.682	0.440
360	4.04	1.024	0.579	3.432	0.566	0.675	0.442
420	4.76	1.028	0.585	3.475	0.569	0.669	0.444
480	5.47	1.013	0.586	3.448	0.579	0.665	0.437
540	6.21	1.016	0.588	3.464	0.579	0.664	0.439
600	6.95	1.019	0.576	3.403	0.566	0.676	0.440
720	8.42	1.006	0.560	3.286	0.557	0.689	0.434
840	9.84	0.994	0.572	3.319	0.576	0.674	0.429
960	11.25	0.998	0.550	3.217	0.551	0.697	0.431
1080	12.65	0.985	0.535	3.120	0.544	0.709	0.425
1200	14.13	0.987	0.538	3.136	0.546	0.706	0.426
1266	15.00	0.986	0.507	3.008	0.515	0.737	0.425

Table 9 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; NCS-IA-89-09-ED-GH
Boring Number : 88-103 MU
Sample Number : 3
Depth : 16'-18'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.317	0.182	1.174	0.574	1.896	0.137
30	0.24	0.684	0.353	1.415	0.517	1.816	0.295
45	0.43	0.909	0.446	1.585	0.491	1.779	0.392
60	0.60	1.046	0.536	1.714	0.513	1.723	0.451
90	0.92	1.231	0.671	1.926	0.545	1.634	0.531
120	1.28	1.345	0.792	2.113	0.589	1.541	0.580
150	1.62	1.441	0.834	2.236	0.579	1.523	0.622
180	1.98	1.501	0.889	2.351	0.593	1.483	0.648
210	2.31	1.527	0.928	2.424	0.608	1.450	0.659
240	2.68	1.569	0.980	2.538	0.625	1.408	0.677
300	3.40	1.601	1.027	2.646	0.642	1.369	0.691
360	4.10	1.599	1.006	2.607	0.629	1.390	0.690
420	4.82	1.596	1.063	2.702	0.666	1.332	0.689
480	5.55	1.609	1.046	2.687	0.650	1.352	0.695
540	6.29	1.622	1.034	2.679	0.638	1.368	0.700
600	7.04	1.617	1.071	2.741	0.663	1.329	0.698
720	8.54	1.592	1.054	2.683	0.663	1.340	0.687
840	9.98	1.583	1.068	2.698	0.675	1.324	0.683
960	11.41	1.574	1.063	2.679	0.676	1.327	0.679
1080	12.83	1.548	1.069	2.664	0.691	1.314	0.668
1200	14.33	1.536	1.042	2.604	0.679	1.338	0.[illegible]
1250	15.00	1.535	1.016	2.562	0.662	1.364	0.663



LL - 56	PL - 23	PI - 33	Gs - 2.69	NAT w - %

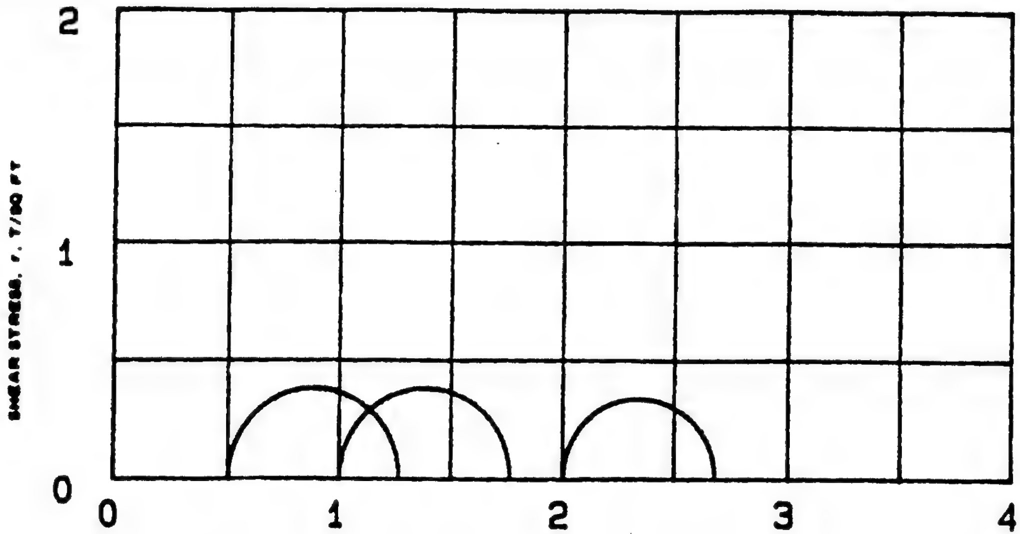
CLASSIFICATION Fat clay, CH
Classification tests run on trimmings from Q test.

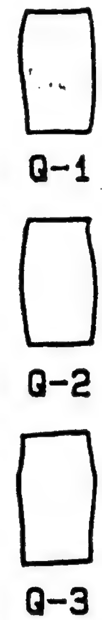
GRADATION CURVE

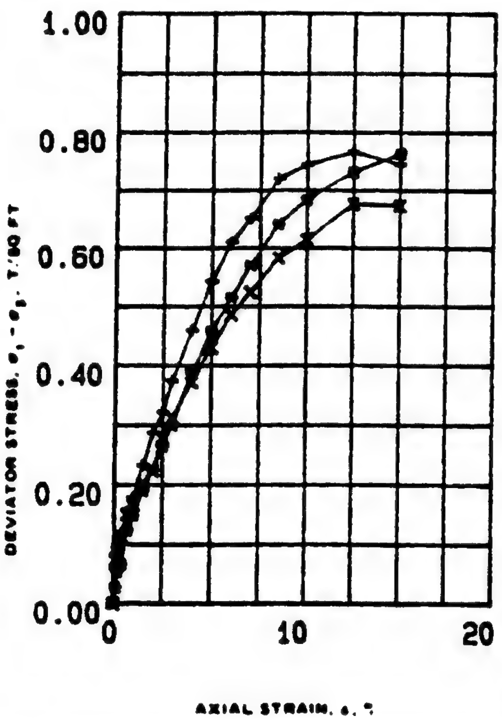
PROJECT	CHASKA: NCS-IA-89-09-ED-GH
BORING NO.	88-103 MU
SAMPLE NO.	3
DEPTH/ELEV	16'-18'
MRD LAB NO.	89/177

FIGURE 28

Figure C-273







NORMAL STRESS, σ, T/SQ FT

	SPECIMEN NO.		1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	39.1	40.3	39.9	
	DRY DENSITY LB/CU FT	γ_{d_o}	83.5	81.9	83.5	
	SATURATION, %	S_o	100.0	100.0	100.0	
	VOID RATIO	e_o	0.97	1.01	0.97	
BEFORE SHEAR	WATER CONTENT, %	w_c	39.0	40.1	39.5	
	DRY DENSITY LB/CU FT	γ_{d_c}	83.5	81.9	83.5	
	SATURATION, %	S_c	100.0	100.0	100.0	
	VOID RATIO	e_c	0.97	1.01	0.97	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.77	0.78	0.68	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	20.3	31.5	23.0	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.74	0.78	0.67	
INITIAL DIAMETER, IN.		D_o	1.41	1.40	1.40	
INITIAL HEIGHT, IN.		H_o	2.94	2.98	2.95	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL

LL 44	PL 22	PI 22	G_s 2.84

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST Q

REMARKS: Dark gray, highly calcareous.
Torvane=0.4 TSF.

PROJECT CHASKA; NCS-IA-88-08-ED-GH

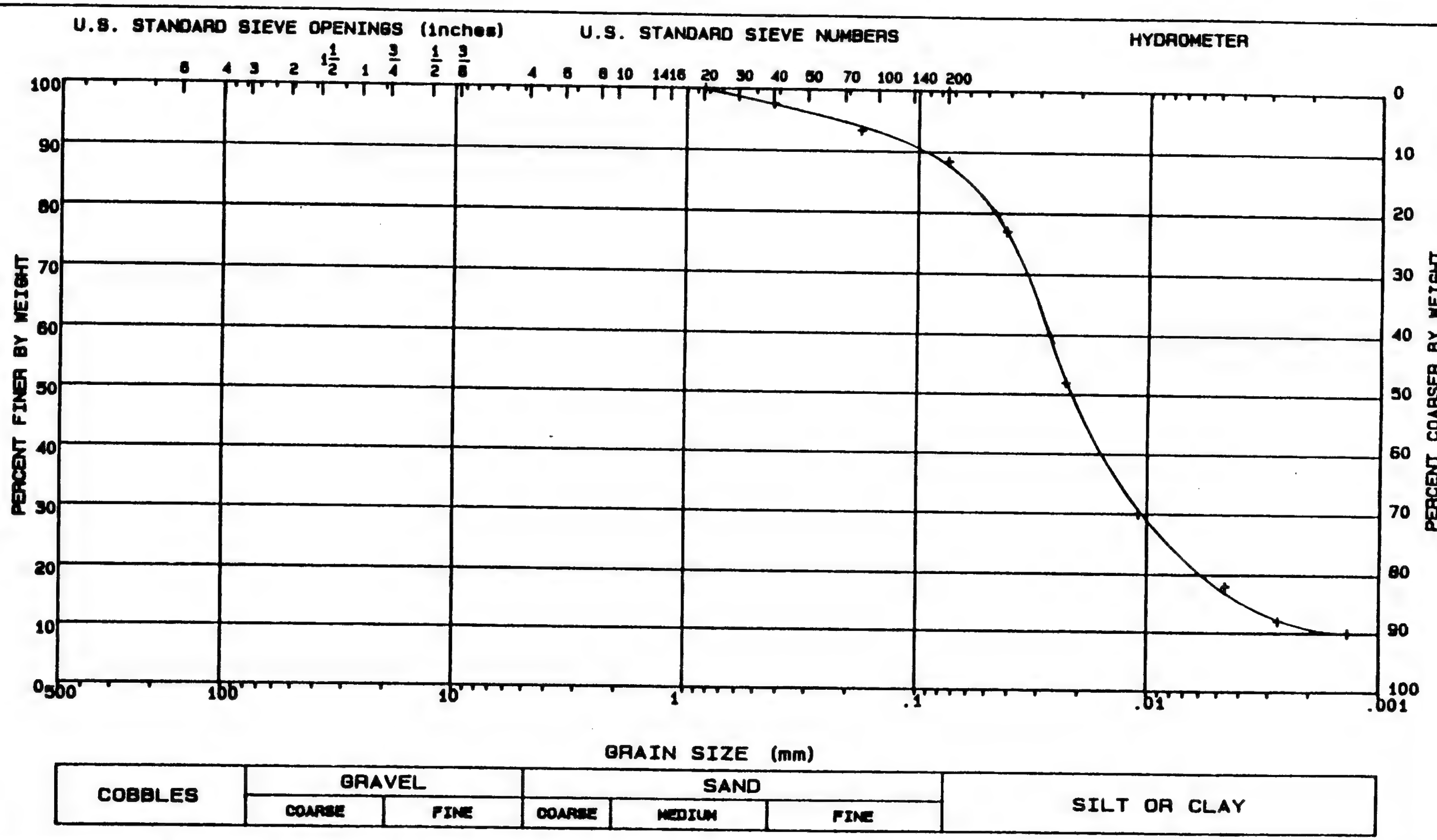
BORING NO 88-103 MU | SAMPLE NO. 4

DEPTH ELEV 21.0'-22.8'

LABORATORY 88/177 | DATE

TRIAXIAL COMPRESSION TEST REPORT

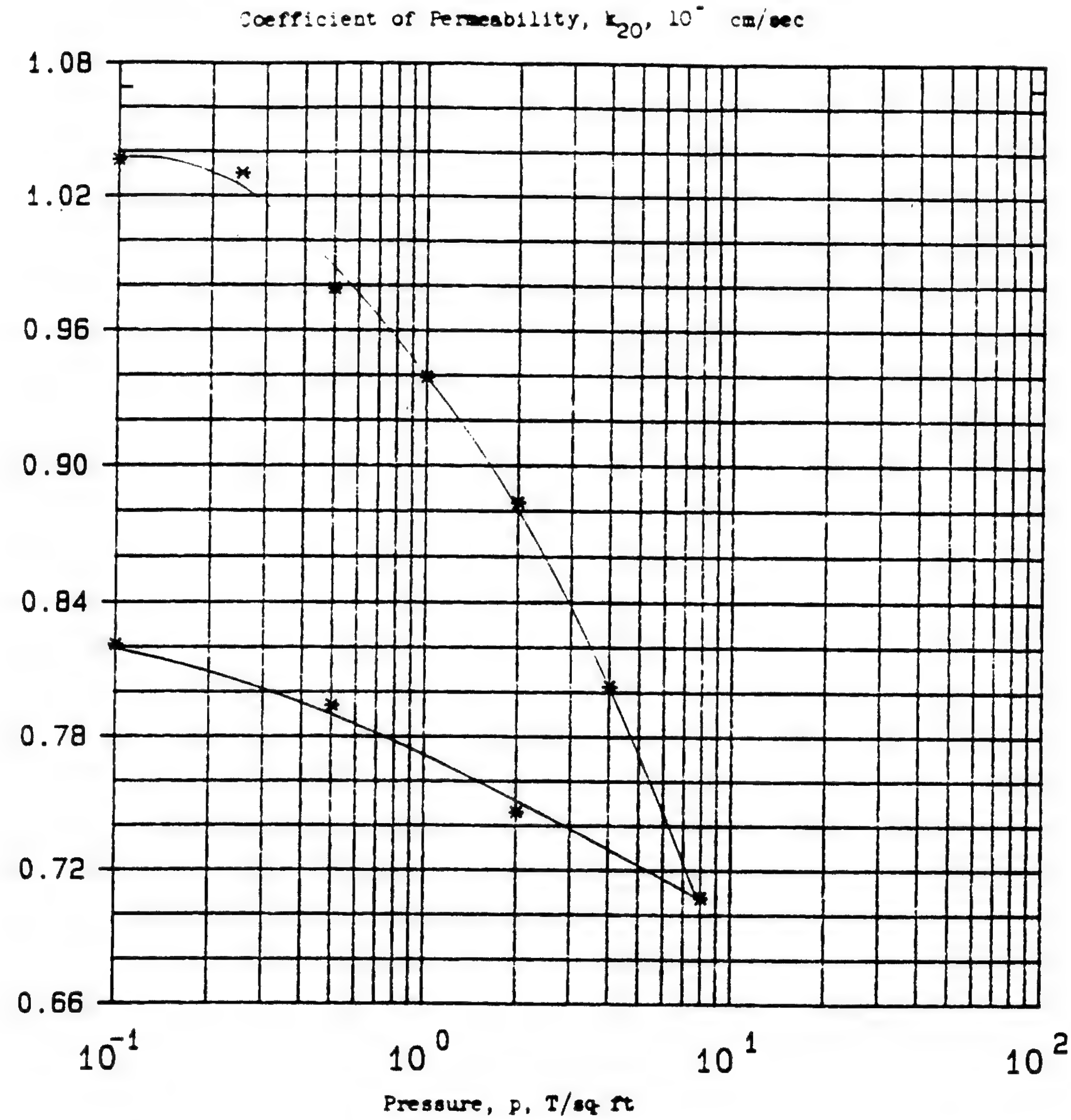
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 27



LL = 44	PL = 22	PI = 22	Gs = 2.64	NAT w = %	PROJECT	CHASKA; NCS-IA-89-09-ED-GH
CLASSIFICATION Lean clay, CL Classification tests run on trimmings from Q test.					BORING NO. SAMPLE NO. DEPTH/ELEV MRD LAB NO.	88-103 MU 4 21.0'-22.8' 89/177
GRADATION CURVE						

FIGURE 28

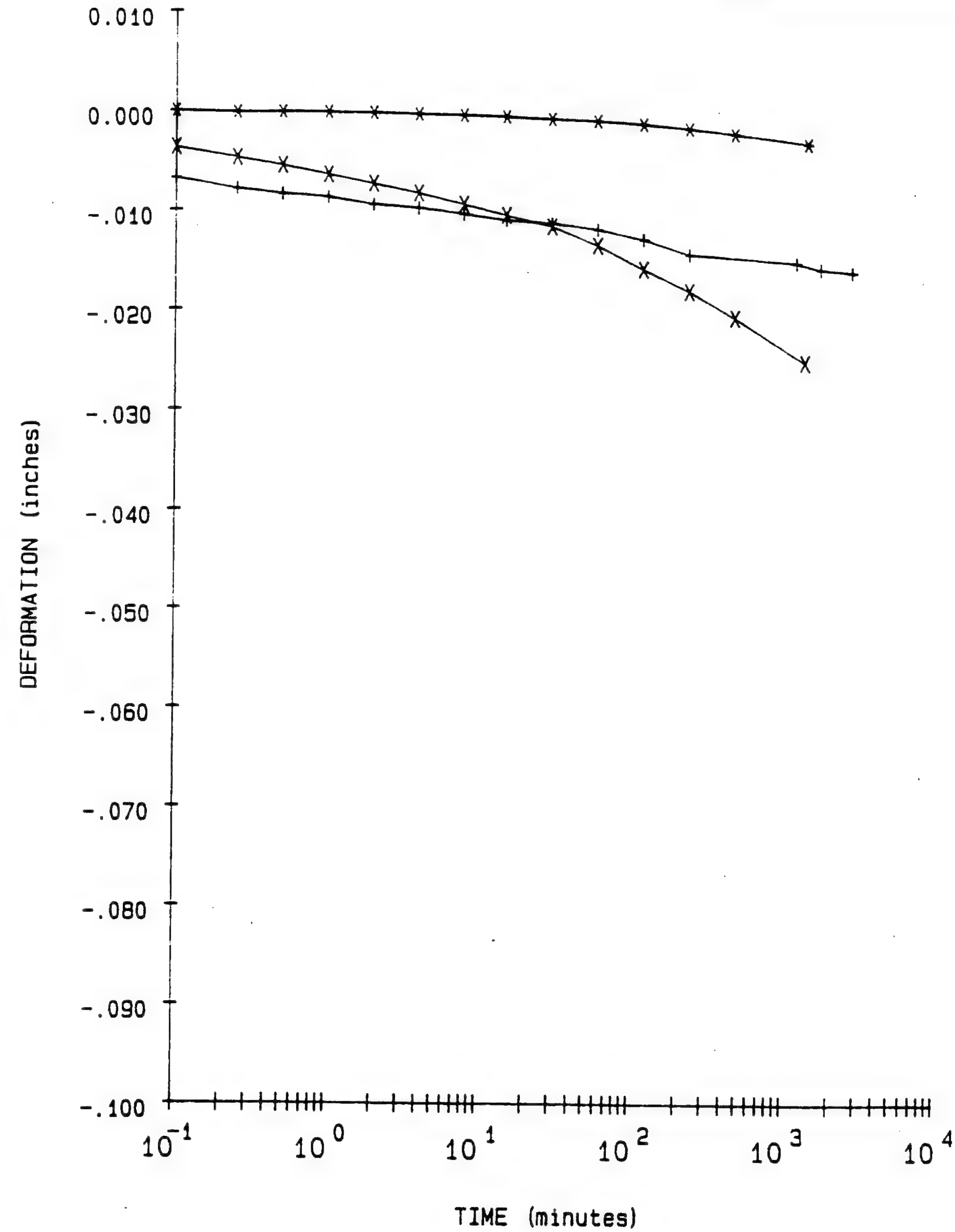
Figure C-275



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.3 in.	Ht 1 in.	Water Content, w_o	36.0 %	w_f	37.9 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.07	e_f	0.82
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	86 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	76.6 lb/ft^3		
Classification Fat clay, CH		k_{20} at e_o = $\times 10^{-}$ cm/sec			
LL 84	G_s 2.54	Project MINNESOTA RIVER: IA-90-04-ED-GH			
PL 32	D_{10}				
Remarks Dark gray, no Torvane.		Area MRD LAB NO. 90/135			
Slightly calcareous.		Boring No. 89-7 MU		Sample No. S-1	
		Depth El 3'-4.1'		Date	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

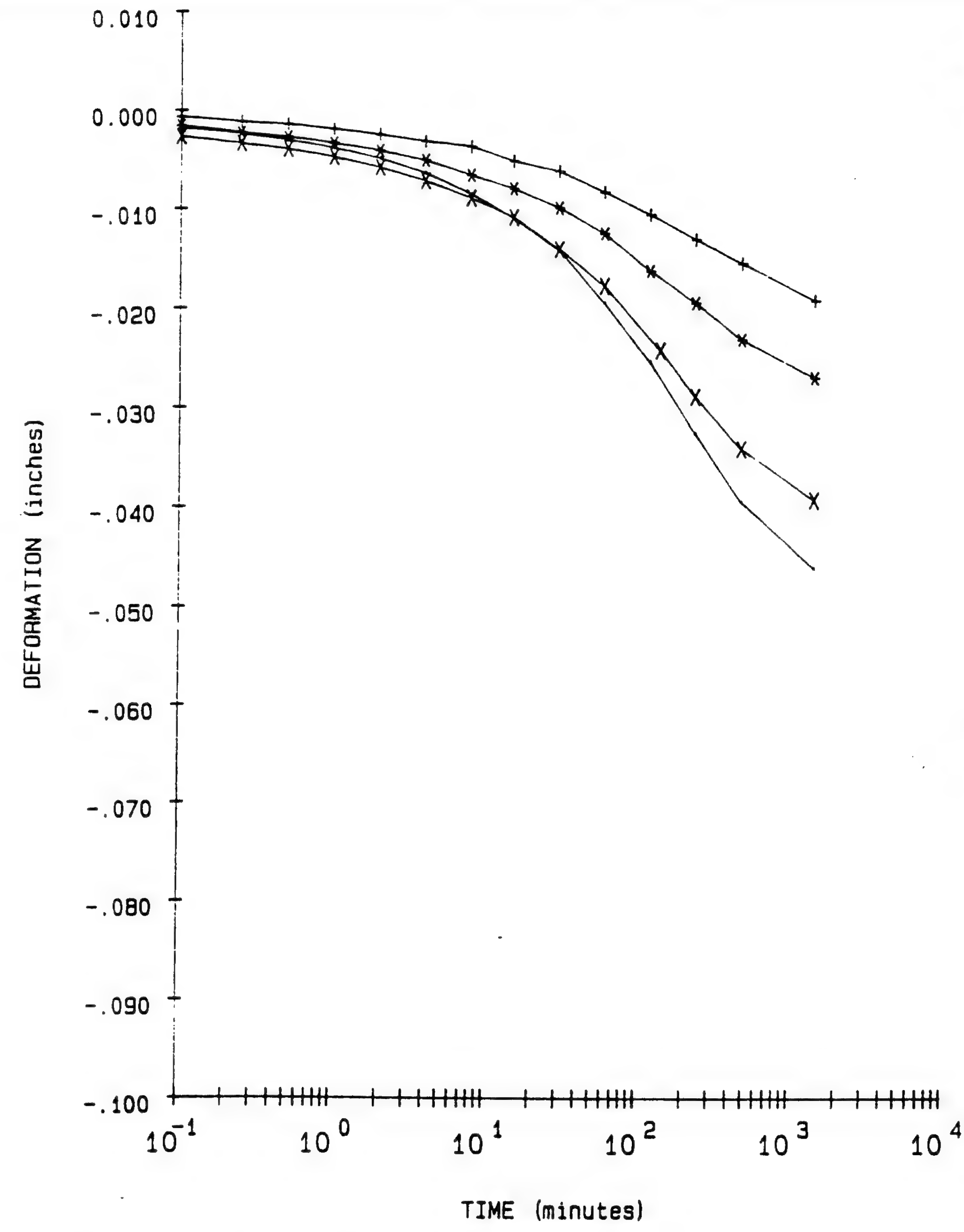
Figure 1



LEGEND	
+ = .1 TSF	
* = .25 TSF	
X = .5 TSF	

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-1
DEPTH/ELEV	3'-4.1'
MRD LAB NO.	90/135

FIGURE 2

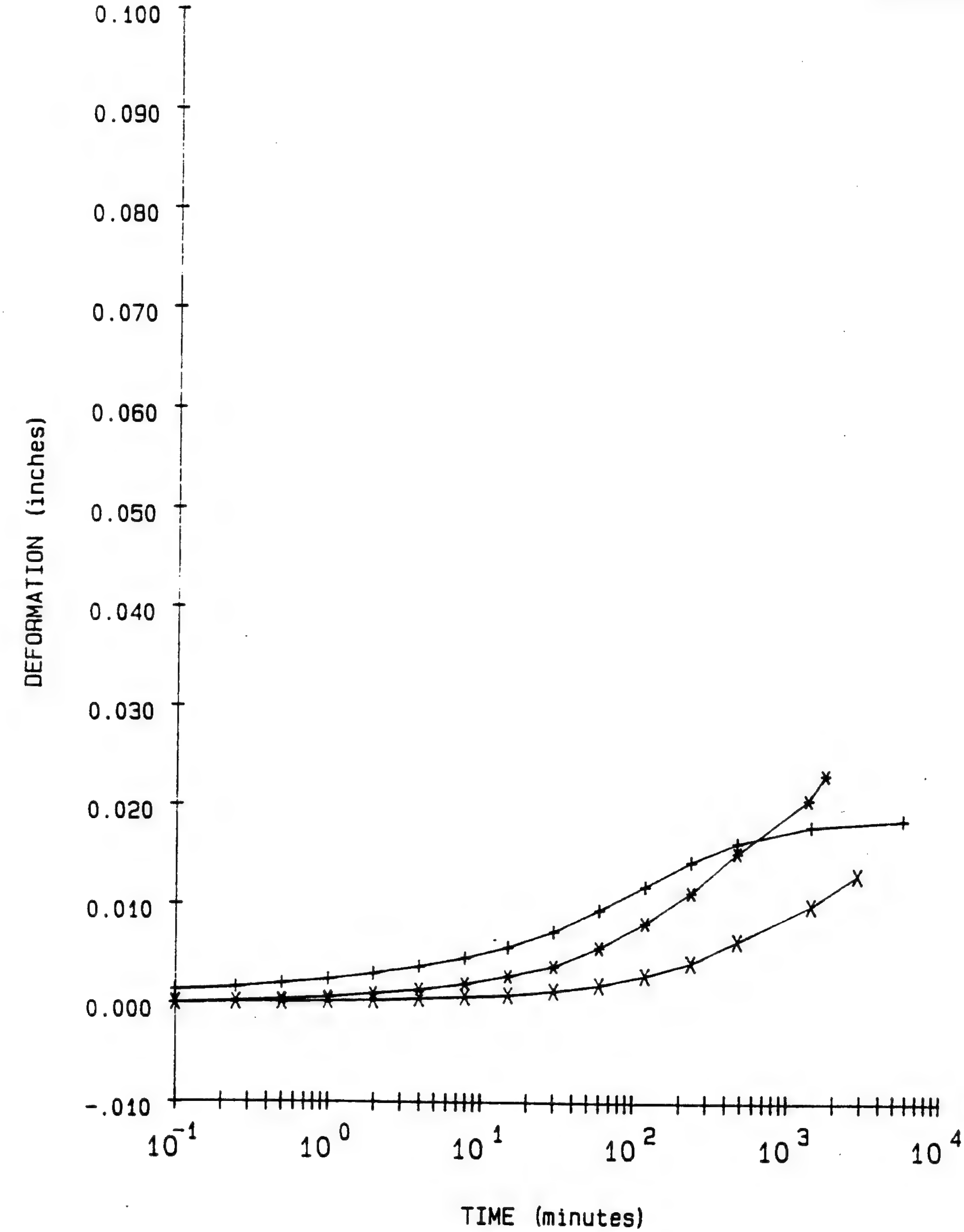


LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF
- = 8 TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-1
DEPTH/ELEV	3'-4.1'
MRD LAB NO.	90/135

FIGURE 3



LEGEND

+ = 2 TSF Rebcund

* = .5 TSF Rebound

X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-1
DEPTH/ELEV	3'-4.1'
MRD LAB NO.	90/135

FIGURE 4

Consolidation Test Data

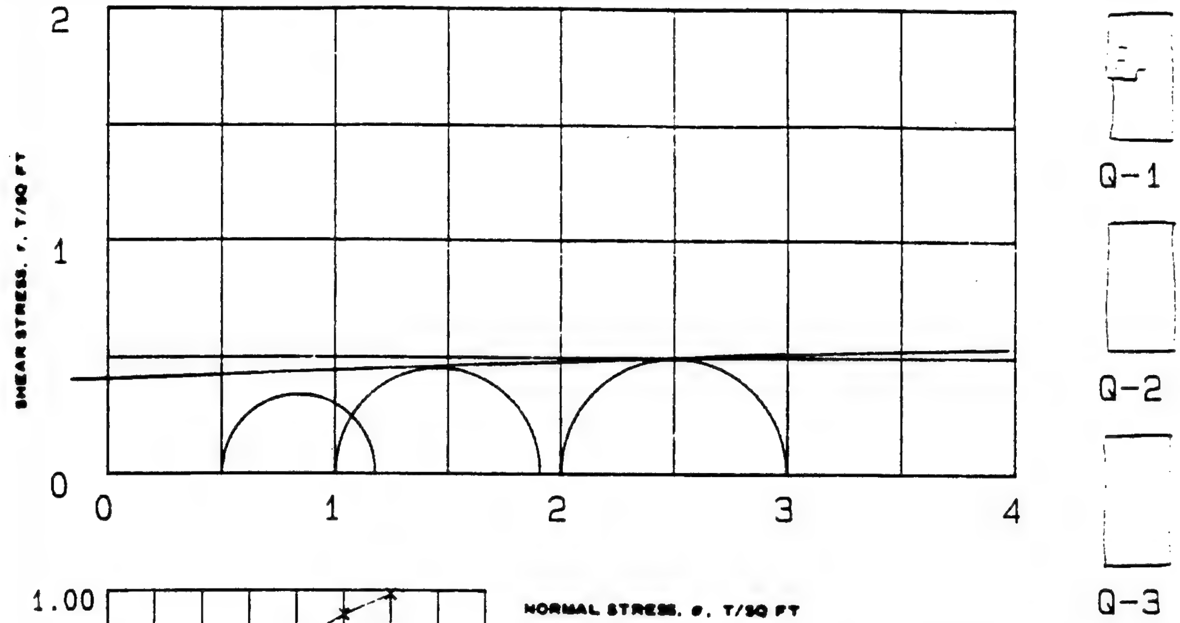
Project MINNESOTA RIVER; IA-90-04-ED-GH

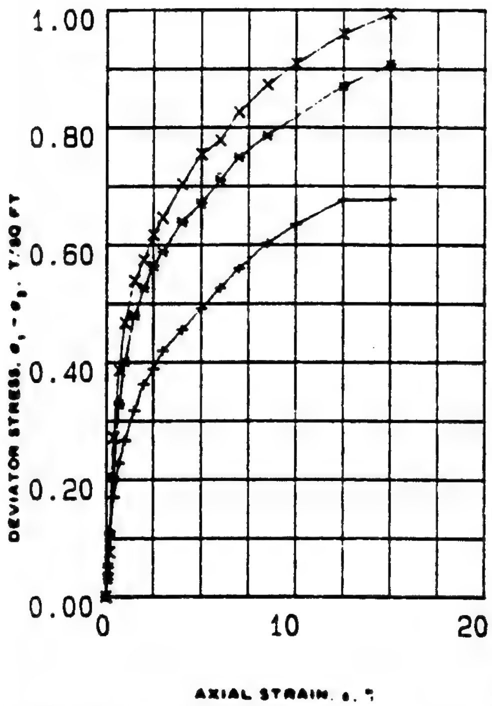
Boring No. 89-7 MU
Sample No. S-1
Depth/Elev 3'-4.1'
MRD Lab No. 90/135

Gs = 2.54
eo = 1.069
0.42eo = 0.449

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
36.0	290.1	76.6	1.069		85.6
37.9	290.1	77.8	1.036	0.10	92.8
37.9	290.1	78.1	1.030	0.25	93.4
37.9	290.1	80.1	0.978	0.50	98.3
37.9	290.1	81.7	0.939	1.00	100.0
37.9	290.1	84.1	0.884	2.00	100.0
37.9	290.1	87.9	0.802	4.00	100.0
37.9	290.1	92.8	0.707	8.00	100.0
37.9	290.1	90.8	0.746	2.00	100.0
37.9	290.1	88.3	0.794	0.50	100.0
37.9	290.1	87.0	0.821	0.10	100.0

Axial Strain (%)	Void Ratio
1	1.048
2	1.028
3	1.007
4	0.986
5	0.966
6	0.945
7	0.924
8	0.903
9	0.883
10	0.862
11	0.841
12	0.821
13	0.800
14	0.779
15	0.759
16	0.738
17	0.717
18	0.697
19	0.676
20	0.655





SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	37.5	41.3	38.0	
INITIAL	DRY DENSITY LB/CU FT	γ_{d_o}	80.3	75.2	81.1	
INITIAL	SATURATION, %	S_o	98.0	94.0	100.0	
INITIAL	VOID RATIO	e_o	0.98	1.11	0.95	
BEFORE SHEAR	WATER CONTENT, %	w_c	37.3	41.1	37.9	
BEFORE SHEAR	DRY DENSITY LB/CU FT	γ_{d_c}	80.5	75.5	82.0	
BEFORE SHEAR	SATURATION, %	S_c	98.0	95.0	100.0	
BEFORE SHEAR	VOID RATIO	e_c	0.97	1.10	0.93	
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.68	0.91	0.99	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	25.0	34.5	31.3	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.68	0.91	0.99	
INITIAL DIAMETER, IN.		D_o	1.39	1.42	1.39	
INITIAL HEIGHT, IN.		H_o	3.00	2.99	2.99	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH

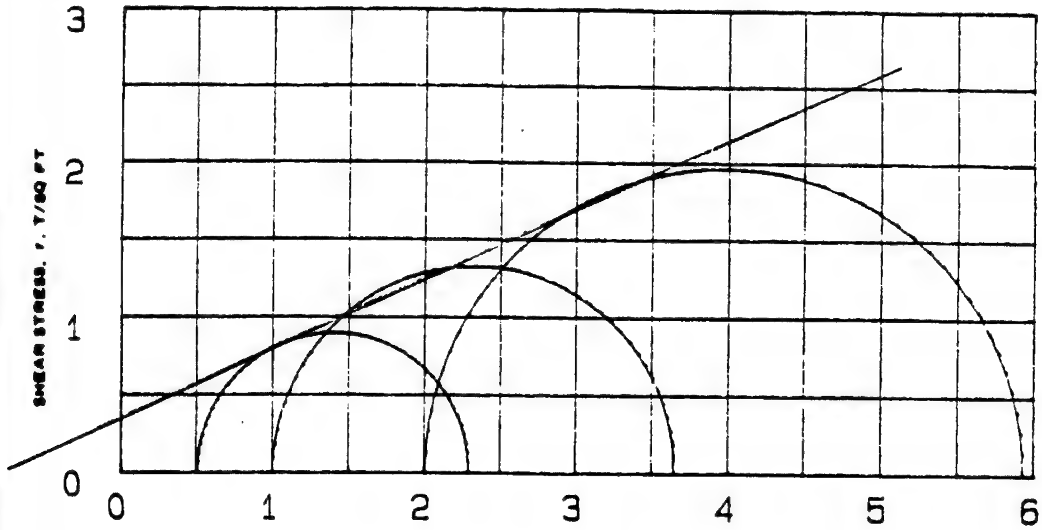
LL 84	PL 32	PI 52	Gs 2.54	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

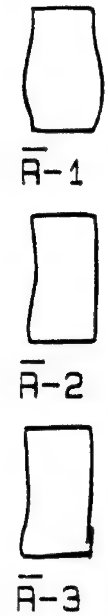
REMARKS: Dark gray, no Torvane. Slightly calcareous.

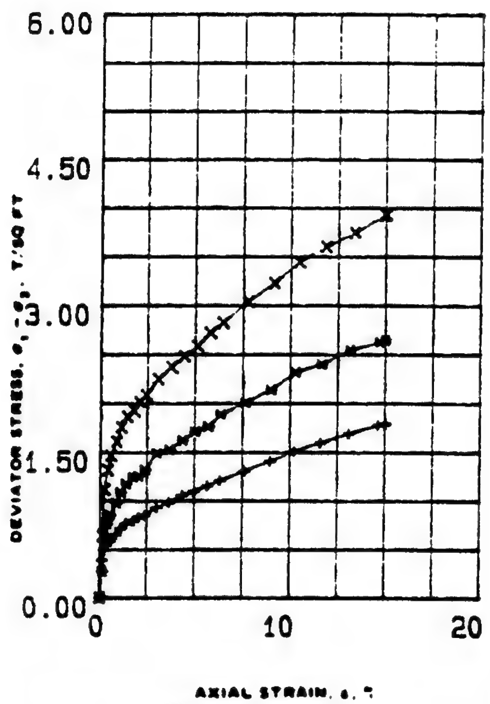
PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO	89-7 MU
SAMPLE NO.	S-1
DEPTH ELEV	3'-4.1'
LABORATORY	90/135
DATE	

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 5







NORMAL STRESS, σ, T/SQ FT

SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	22.2	22.2	22.4	
	DRY DENSITY LB/CU FT	γd_o	105	105	103	
	SATURATION, %	S_o	100	100	100	
	VOID RATIO	e_o	.51	.51	.54	
BEFORE SHEAR	WATER CONTENT, %	w_c	21.4	20.5	19.7	
	DRY DENSITY LB/CU FT	γd_c	105.2	105.6	105.9	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.51	.5	.5	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.823	4.823	4.823	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.791	2.649	3.928	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1353	1347	1327	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.791	2.649	3.928	
INITIAL DIAMETER, IN.		D_o	1.41	1.4	1.43	
INITIAL HEIGHT, IN.		H_o	3	2.99	2.96	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH B-value 1.0 1.0 1.0

LL 84 | PL 32 | PI 52 | G_s 2.54

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST RBAR

REMARKS: Dark gray, no Torvane.
Slightly calcareous.

PROJECT MINNESOTA RIVER: IA-90-04-ED-8H

BORING NO. 89-7 MU | SAMPLE NO. S-1

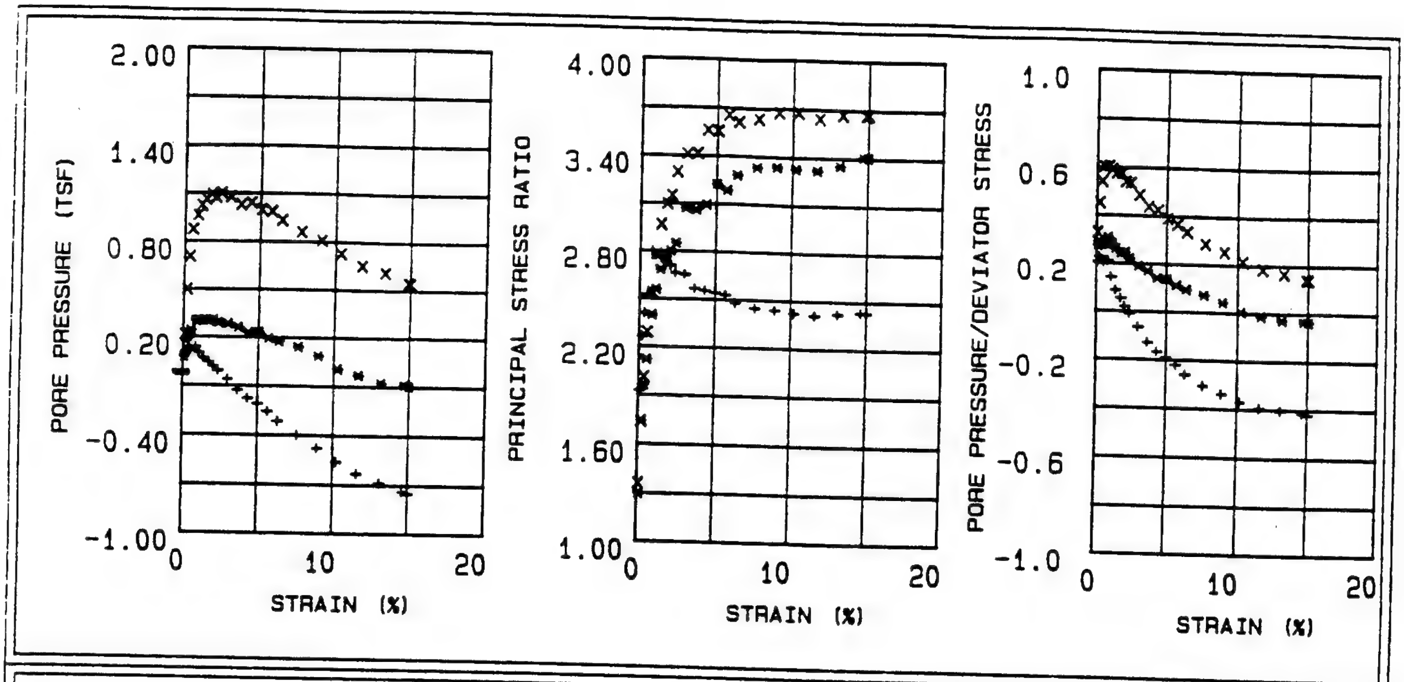
DEPTH ELEV 3'-4.1'

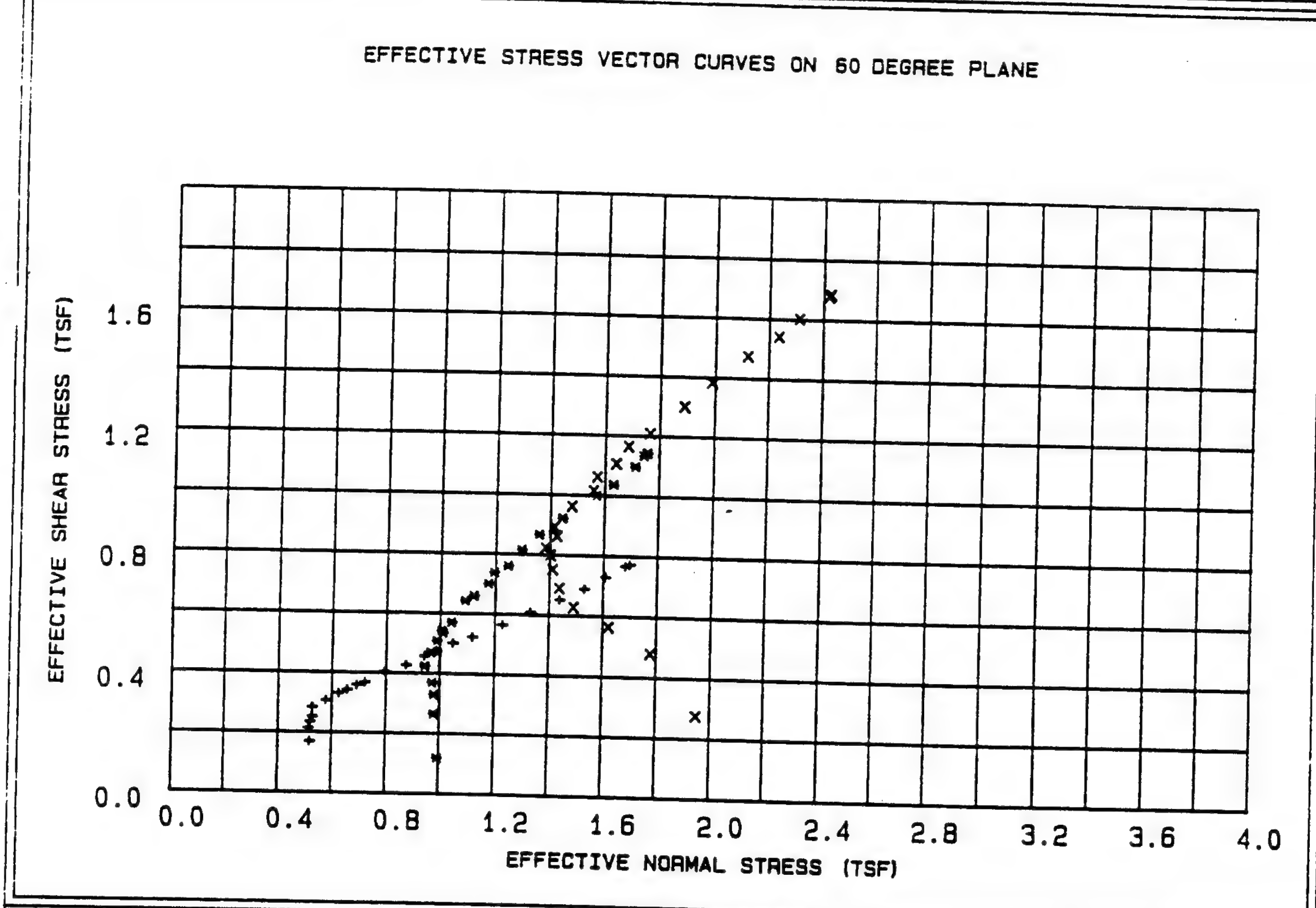
LABORATORY 90/135 | DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 6





LEGEND

+ = .5 TSF

* = 1 TSF

X = 2 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-1
DEPTH/ELEV	3'-4.1'
MRD LAB NO.	90/135

FIGURE 7

R

Table 1 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-7 MU
Sample Number : S-1
Depth : 3'-4.1'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.390	0.079	1.925	0.203	0.518	0.168
30	0.24	0.492	0.110	2.260	0.224	0.512	0.212
45	0.38	0.541	0.115	2.406	0.213	0.519	0.234
60	0.55	0.582	0.117	2.521	0.202	0.527	0.251
90	0.85	0.654	0.136	2.798	0.209	0.526	0.282
120	1.09	0.710	0.099	2.770	0.140	0.577	0.306
150	1.38	0.765	0.065	2.759	0.085	0.624	0.330
180	1.76	0.793	0.040	2.723	0.051	0.656	0.342
210	2.04	0.830	0.014	2.707	0.017	0.691	0.358
240	2.37	0.849	-0.011	2.661	-0.013	0.721	0.367
300	2.99	0.930	-0.064	2.650	-0.068	0.794	0.402
360	3.65	0.984	-0.130	2.563	-0.132	0.874	0.425
420	4.32	1.054	-0.180	2.550	-0.170	0.941	0.45[illegible]
[illegible]	4.98	1.098	-0.214	2.538	-0.194	0.986	0.474
[illegible]	5.65	1.157	-0.259	2.525	-0.223	1.046	0.500
600	6.31	1.208	-0.319	2.475	-0.263	1.118	0.521
720	7.59	1.307	-0.404	2.446	-0.308	1.228	0.564
840	8.92	1.409	-0.481	2.436	-0.341	1.330	0.608
960	10.20	1.509	-0.564	2.419	-0.373	1.438	0.651
1080	11.58	1.595	-0.634	2.407	-0.397	1.529	0.688
1200	13.08	1.688	-0.689	2.420	-0.407	1.607	0.729
1320	14.62	1.776	-0.741	2.431	-0.417	1.681	0.767
1353	15.00	1.791	-0.754	2.428	-0.421	1.697	0.773

Table 2 - Triaxial $\bar{R}$ Test Results

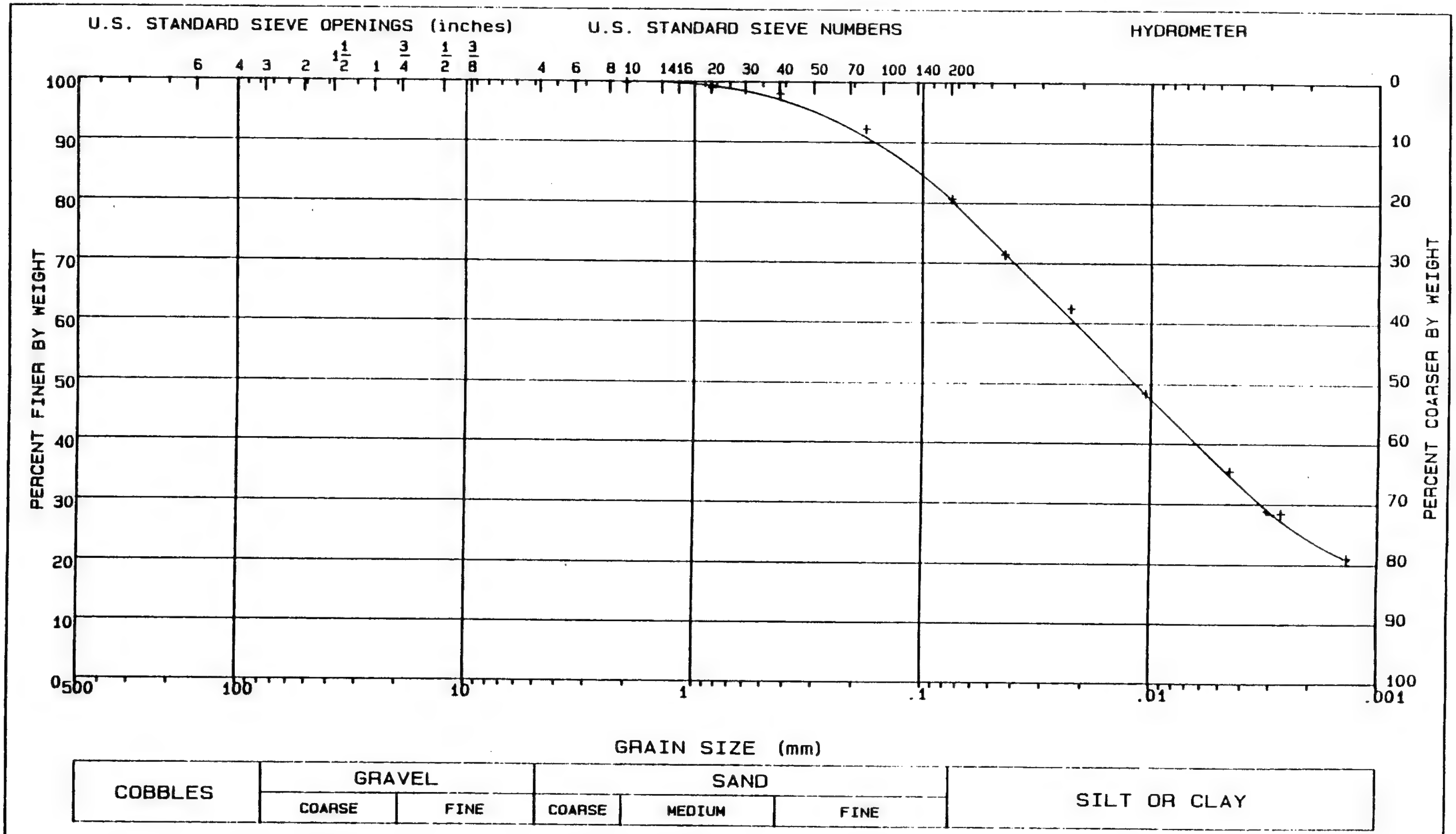
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-7 MU
Sample Number : S-1
Depth : 3'-4.1'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.272	0.074	1.293	0.272	0.993	0.117
30	0.24	0.611	0.173	1.739	0.284	0.978	0.264
45	0.38	0.760	0.210	1.963	0.277	0.978	0.328
60	0.55	0.852	0.240	2.120	0.282	0.971	0.368
90	0.86	0.978	0.299	2.396	0.307	0.943	0.422
120	1.10	1.086	0.303	2.558	0.279	0.966	0.469
150	1.38	1.174	0.303	2.684	0.258	0.988	0.507
180	1.76	1.241	0.297	2.765	0.240	1.010	0.535
210	2.05	1.253	0.305	2.803	0.244	1.005	0.541
240	2.38	1.320	0.286	2.849	0.218	1.041	0.570
300	3.00	1.490	0.279	3.067	0.188	1.090	0.643
360	3.67	1.528	0.257	3.057	0.169	1.121	0.659
420	4.34	1.620	0.226	3.092	0.140	1.175	0.699
480	5.01	1.711	0.229	3.219	0.134	1.195	0.738
[illegible]	5.68	1.764	0.192	3.182	0.109	1.245	0.761
[illegible]	6.34	1.887	0.172	3.279	0.092	1.295	0.815
720	7.63	2.007	0.139	3.331	0.070	1.358	0.866
840	8.96	2.138	0.085	3.337	0.040	1.444	0.923
960	10.25	2.317	0.004	3.325	0.002	1.570	1.000
1080	11.64	2.402	-0.036	3.318	-0.015	1.631	1.037
1200	13.14	2.544	-0.081	3.354	-0.031	1.711	1.098
1320	14.69	2.629	-0.092	3.407	-0.035	1.743	1.135
1347	15.00	2.649	-0.101	3.406	-0.038	1.756	1.143

Table 3 - Triaxial $\overline{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-7 MU
Sample Number : S-1
Depth : 3'-4.1'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.638	0.208	1.356	0.326	1.950	0.275
30	0.24	1.107	0.496	1.736	0.449	1.778	0.478
45	0.39	1.306	0.702	2.007	0.538	1.621	0.564
60	0.56	1.453	0.871	2.287	0.600	1.489	0.627
90	0.87	1.596	0.960	2.535	0.602	1.435	0.689
120	1.11	1.740	1.022	2.779	0.588	1.409	0.751
150	1.40	1.849	1.058	2.963	0.573	1.400	0.798
180	1.78	1.905	1.091	3.094	0.573	1.381	0.822
210	2.07	1.995	1.070	3.145	0.537	1.424	0.861
240	2.41	2.068	1.099	3.295	0.532	1.413	0.892
300	3.04	2.228	1.075	3.409	0.483	1.477	0.962
360	3.71	2.353	1.025	3.414	0.436	1.557	1.015
420	4.38	2.459	1.039	3.559	0.423	1.570	1.061
480	5.06	2.563	0.996	3.553	0.389	1.639	1.10
[illegible]	5.74	2.697	0.984	3.655	0.365	1.684	1.164
[illegible]	6.41	2.798	0.929	3.613	0.333	1.764	1.208
720	7.71	3.011	0.857	3.634	0.285	1.889	1.300
840	9.06	3.200	0.804	3.675	0.252	1.988	1.381
960	10.36	3.413	0.725	3.676	0.213	2.120	1.473
1080	11.76	3.569	0.649	3.642	0.182	2.235	1.541
1200	13.28	3.712	0.608	3.667	0.164	2.311	1.602
1320	14.84	3.888	0.543	3-.668	0.140	2.420	1.678
1333	15.00	3.902	0.540	3.672	0.139	2.426	1.684



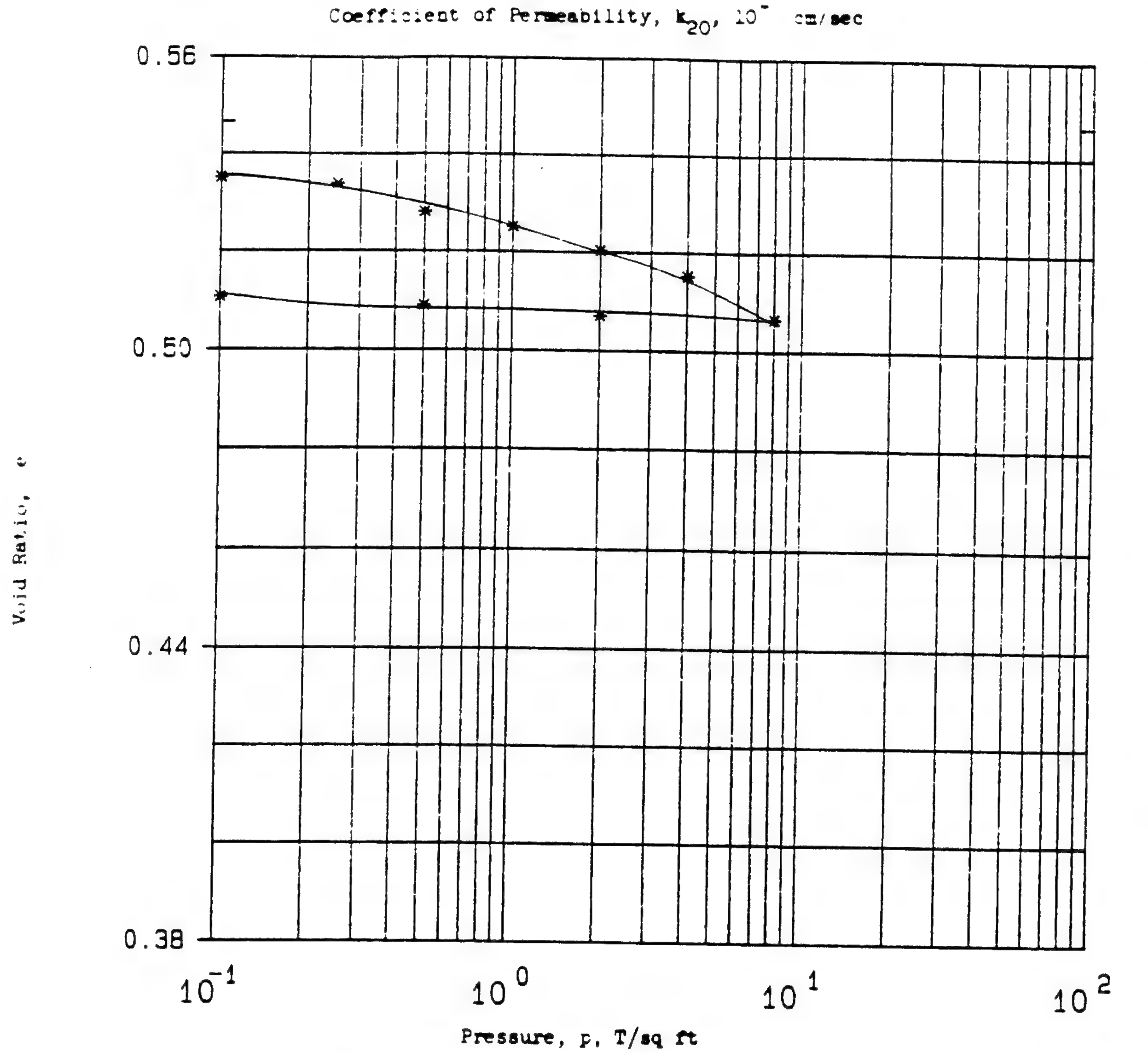
LL - 84	PL - 32	PI - 52	Gs - 2.54	NAT w - %

CLASSIFICATION Fat clay, CH

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-1
DEPTH/ELEV	3'-4'
MRD LAB NO.	90/135

GRADATION CURVE

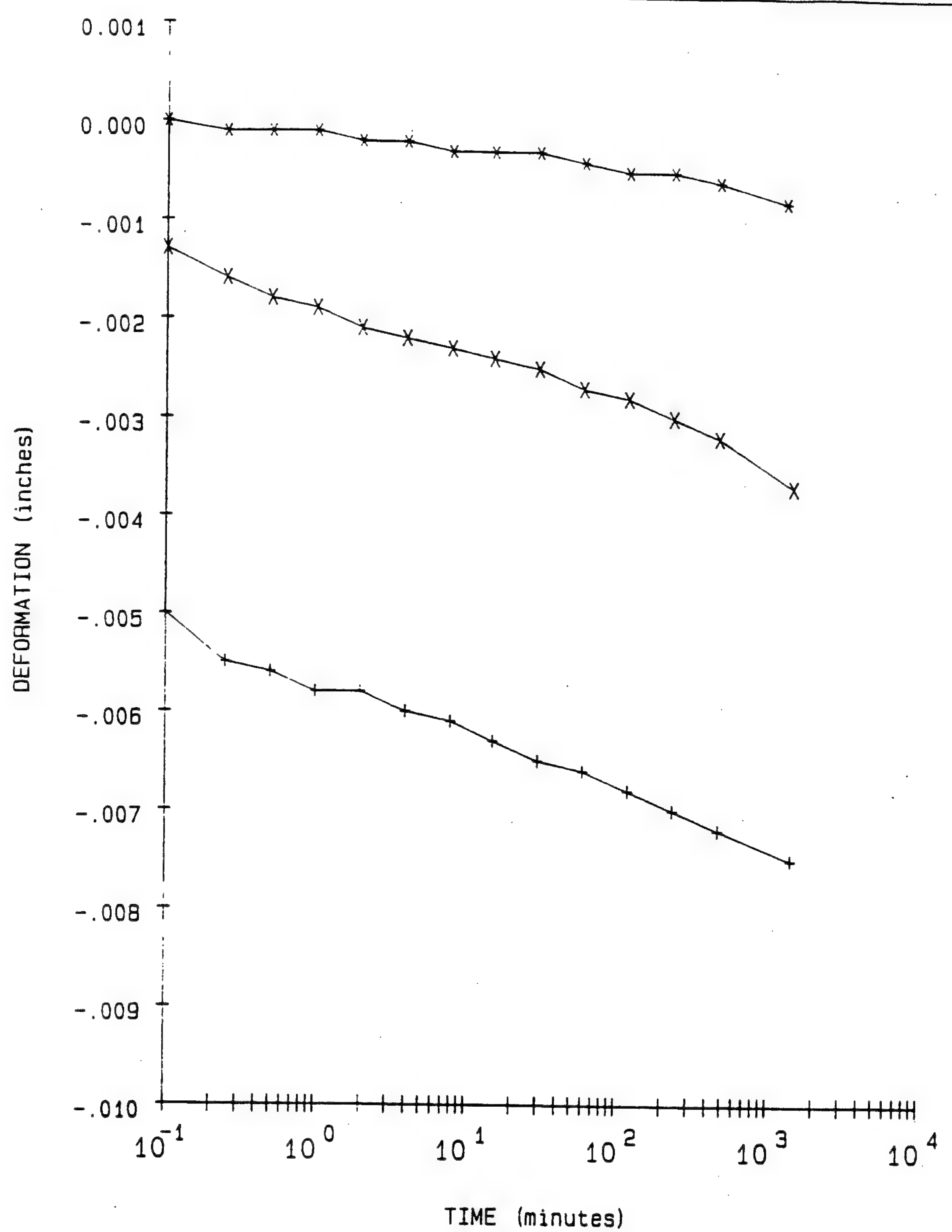
FIGURE 8



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.3 in.	Ht .997in.	Water Content, w_o	19.6 %	w_f	18.9 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	0.55	e_f	0.51
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	97 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	109.7 lb/ft^3		
Classification Lean clay, CL		k_{20} at e_o = × 10^{-} cm/sec			
LL 23	G_s 2.72	Project	MINNESOTA RIVER: IA-90-04-ED-GH		
PL 21	D_{10}				
Remarks Medium Gray		Area	MRD LAB NO. 90/135		
No Torvane		Boring No. 89-7 MU		Sample No. S-3	
Calcareous		Depth El 20'-22'		Date	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

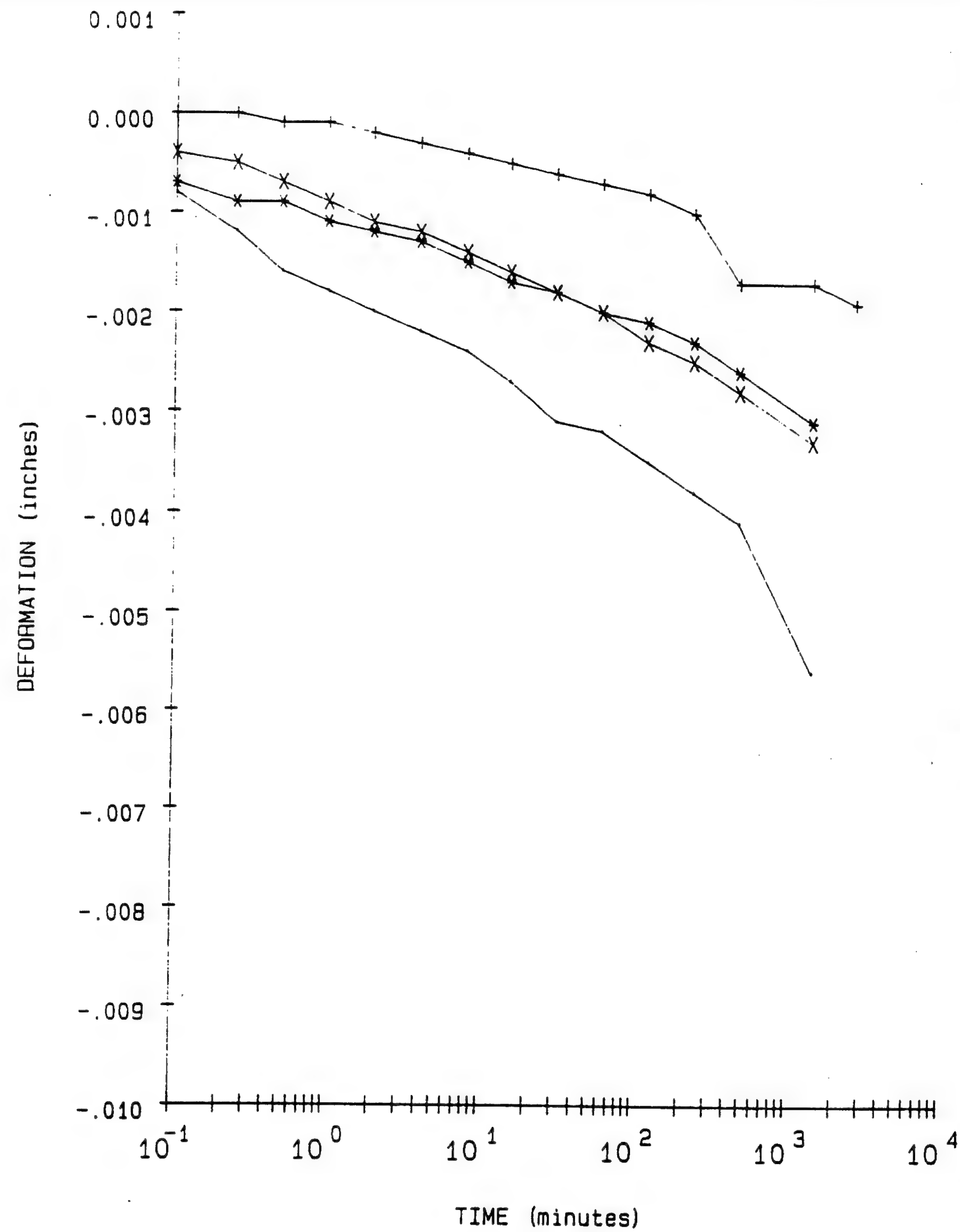
Figure 1



LEGEND	
+ =	.1 TSF
* =	.25 TSF
X =	.5 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-3
DEPTH/ELEV	20'-22'
MRD LAB NO.	90/135

FIGURE 2

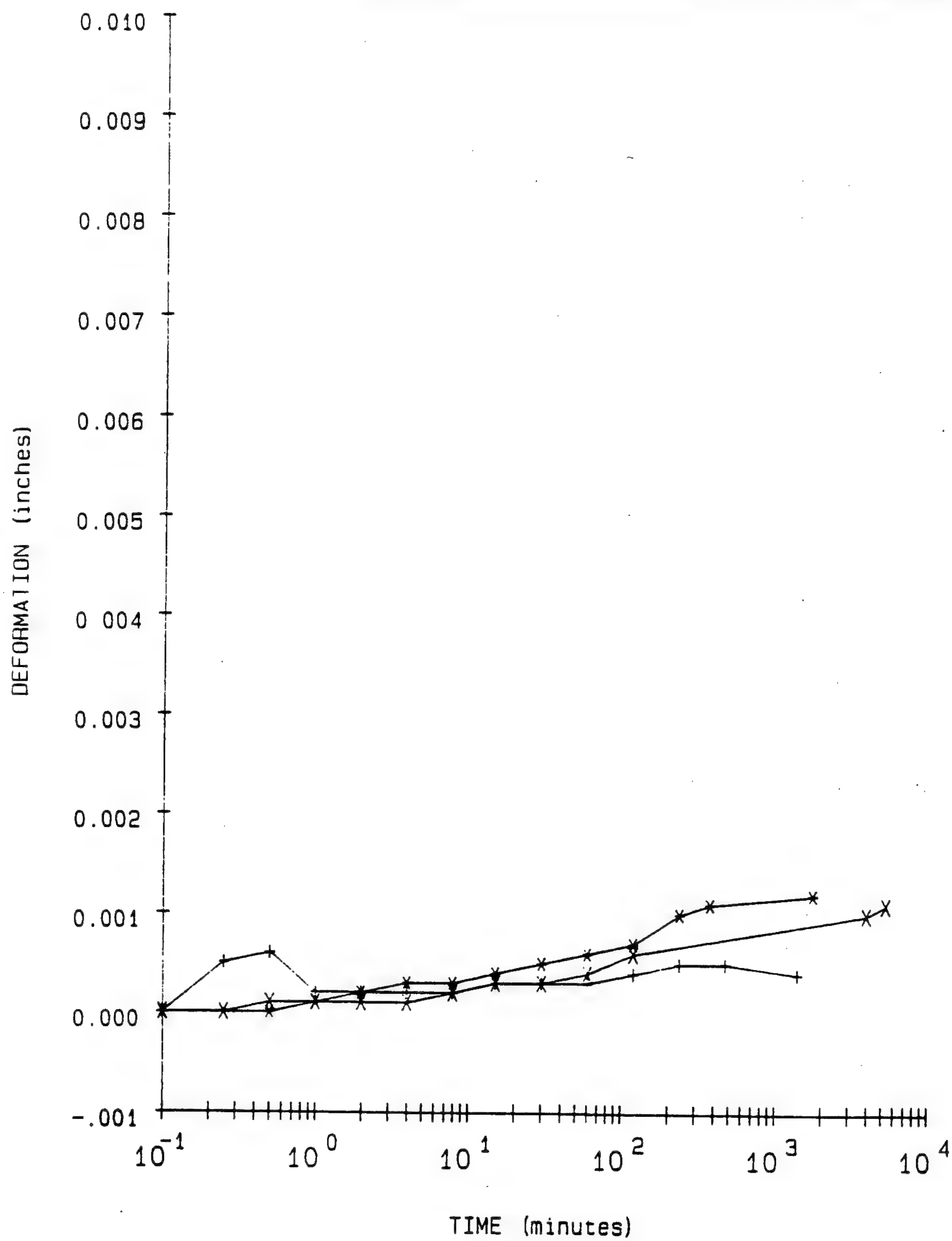


LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF
- = 8 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-3
DEPTH/ELEV	20'-22'
MRD LAB NO.	90/135

FIGURE 3



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-3
DEPTH/ELEV	20'-22'
MRD LAB NO.	90/135

FIGURE 4

Consolidation Test Data

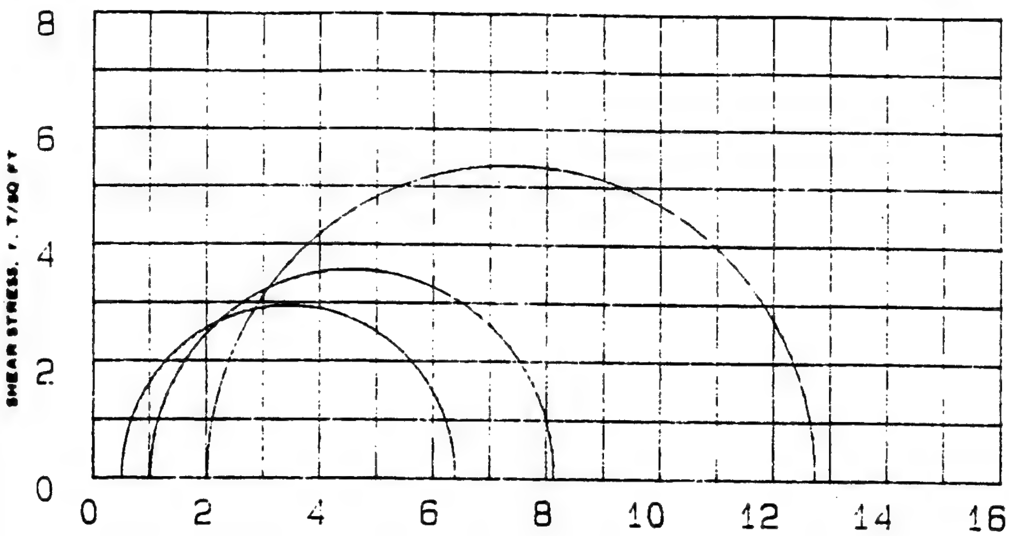
Project	MINNESOTA RIVER; IA-90-04-ED-GH
Boring No.	89-7 MU
Sample No.	S-3
Depth/Elev	20'-22'
MRD Lab No.	90/135

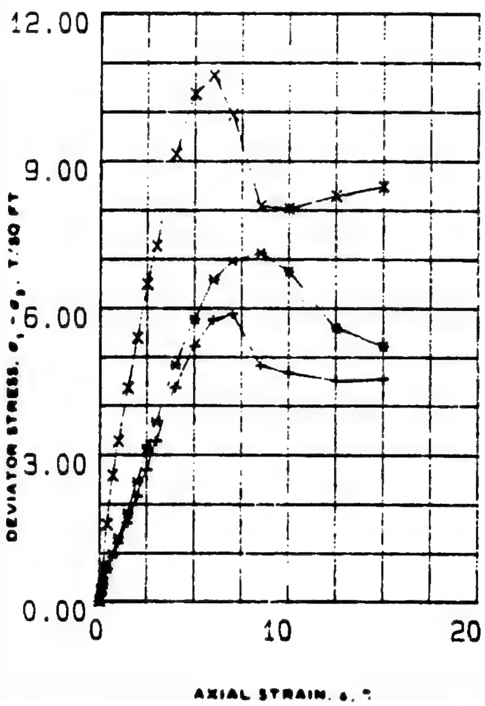
Gs = 2.72
eo = 0.547
0.42eo = 0.230

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
19.6	415.7	109.7	0.547		97.4
18.9	415.7	110.6	0.535	0.10	96.3
18.9	415.7	110.7	0.534	0.25	96.5
18.9	415.7	111.1	0.528	0.50	97.6
18.9	415.7	111.3	0.525	1.00	98.1
18.9	415.7	111.6	0.520	2.00	99.0
18.9	415.7	112.0	0.515	4.00	100.0
18.9	415.7	112.7	0.506	8.00	100.0
18.9	415.7	112.6	0.507	2.00	100.0
18.9	415.7	112.5	0.509	0.50	100.0
18.9	415.7	112.4	0.511	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.531
2	0.516
3	0.500
4	0.485
5	0.469

Consolidation Test Data





SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	18.4	18.4	18.2
	DRY DENSITY LB/CU FT	γ_{d_o}	113.2	113.0	112.3
	SATURATION, %	S_o	100.0	99.0	97.0
	VOID RATIO	e_o	0.50	0.50	0.51
BEFORE SHEAR	WATER CONTENT, %	w_c	18.3	18.4	18.1
	DRY DENSITY LB/CU FT	γ_{d_c}	113.2	113.0	112.3
	SATURATION, %	S_c	100.0	99.0	96.0
	VOID RATIO	e_c	0.50	0.50	0.51
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	5.89	7.13	10.74
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	17.0	22.3	18.5
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	4.55	5.22	8.48
INITIAL DIAMETER, IN.		D_o	1.42	1.42	1.40
INITIAL HEIGHT, IN.		H_o	3.00	3.00	3.00

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL

LL 23 | PL 21 | PI 2 | G_s 2.72

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST Q

REMARKS: Medium Gray
No Torvane
Calcareous

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

BORING NO. 89-7MU | SAMPLE NO. S-3

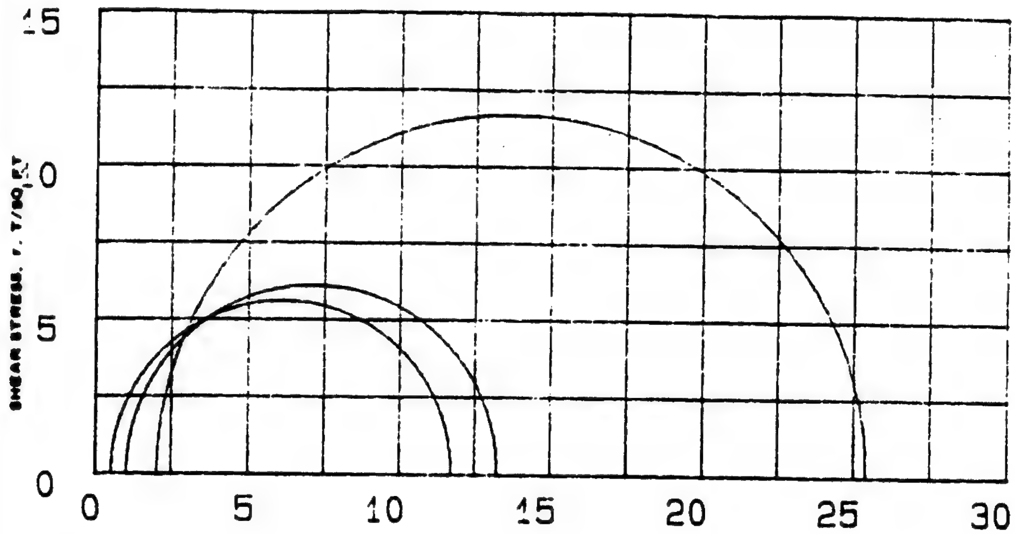
DEPTH ELEV 20'-22'

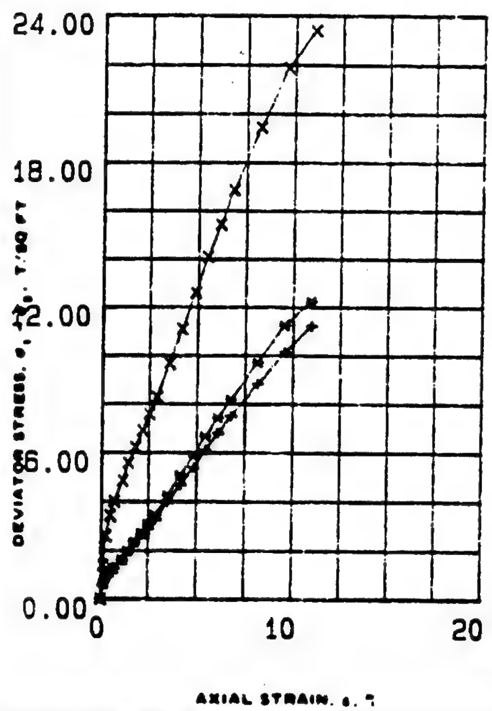
LABORATORY 90/135 | DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 5





SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	20.4	20.1	19.9	
	DRY DENSITY LB/CU FT	γd_o	109.2	110.1	109.7	
	SATURATION, %	S_o	100	100	99	
	VOID RATIO	e_o	.56	.54	.55	
BEFORE SHEAR	WATER CONTENT, %	w_c	20.6	20.5	19.5	
	DRY DENSITY LB/CU FT	γd_c	109	109.8	110.9	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.56	.55	.53	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.823	4.823	4.823	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	11.218	12.233	23.397	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	960	960	960	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	11.218	12.233	23.397	
INITIAL DIAMETER, IN.		D_o	1.41	1.41	1.42	
INITIAL HEIGHT, IN.		H_o	2.99	3	2.98	

CONTROLLED- STRAIN TEST

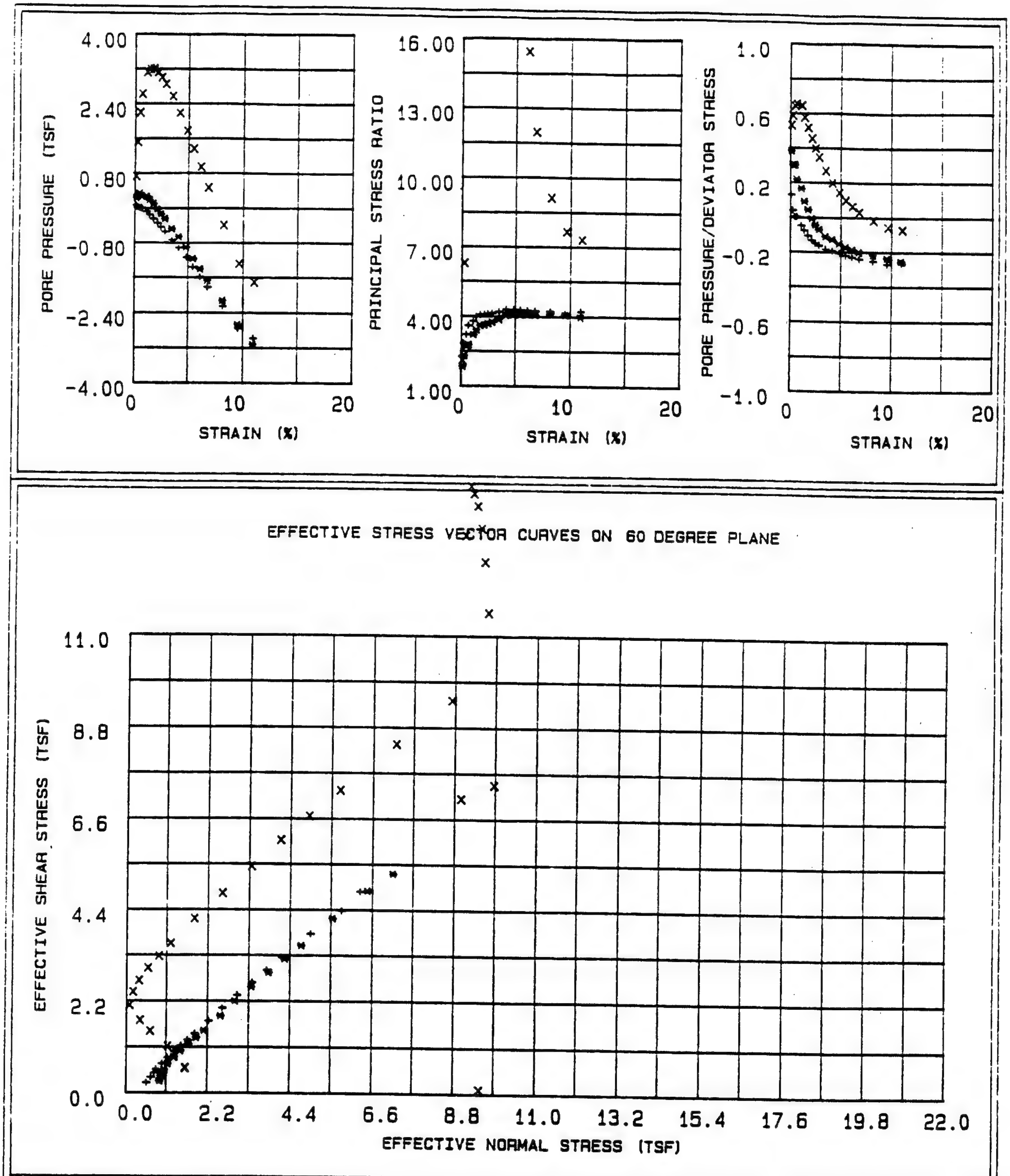
DESCRIPTION OF SPECIMENS Lean clay, CL

LL 23	PL 21	PI 2	G 2.72	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Medium Gray	PROJECT MINNESOTA RIVER: IA-90-04-ED-8H
No Torvane	
Calcareous	BORING NO. 89-7 MU — SAMPLE NO. S-3
	DEPTH ELEV 20'-22'
	LABORATORY 90/135 — DATE
	TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 6



LEGEND

+ = .5 TSF
* = 1 TSF
X = 2 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-3
DEPTH/ELEV	20'-22'
MRD LAB NO.	90/135

FIGURE 7

R

Table 1 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-7 MU
Sample Number : S-3
Depth : 20'-22'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.542	0.069	2.259	0.128	0.565	0.234
30	0.26	0.851	0.032	2.817	0.038	0.679	0.367
45	0.48	1.105	0.000	3.211	0.001	0.774	0.477
60	0.67	1.291	0.001	3.589	0.002	0.819	0.557
90	1.12	1.615	-0.081	3.780	-0.050	0.981	0.697
120	1.40	1.940	-0.152	3.978	-0.078	1.132	0.837
150	1.76	2.279	-0.247	4.051	-0.108	1.311	0.983
180	2.14	2.614	-0.352	4.067	-0.134	1.499	1.128
210	2.47	2.931	-0.446	4.098	-0.152	1.672	1.265
240	2.85	3.278	-0.547	4.130	-0.166	1.859	1.415
300	3.49	3.977	-0.745	4.195	-0.187	2.230	1.717
360	4.14	4.692	-0.925	4.291	-0.197	2.587	2.025
420	4.83	5.401	-1.145	4.284	-0.211	2.982	2.33[illegible]
[illegible]	5.44	6.114	-1.374	4.262	-0.224	3.388	2.639
[illegible]	6.08	6.798	-1.597	4.242	-0.234	3.780	2.934
600	6.77	7.500	-1.828	4.222	-0.243	4.185	3.237
720	8.15	8.831	-2.259	4.200	-0.255	4.945	3.812
840	9.55	10.140	-2.766	4.104	-0.272	5.776	4.376
960	10.96	11.218	-2.991	4.213	-0.266	6.268	4.842

Table 2 - Triaxial $\bar{R}$ Test Results

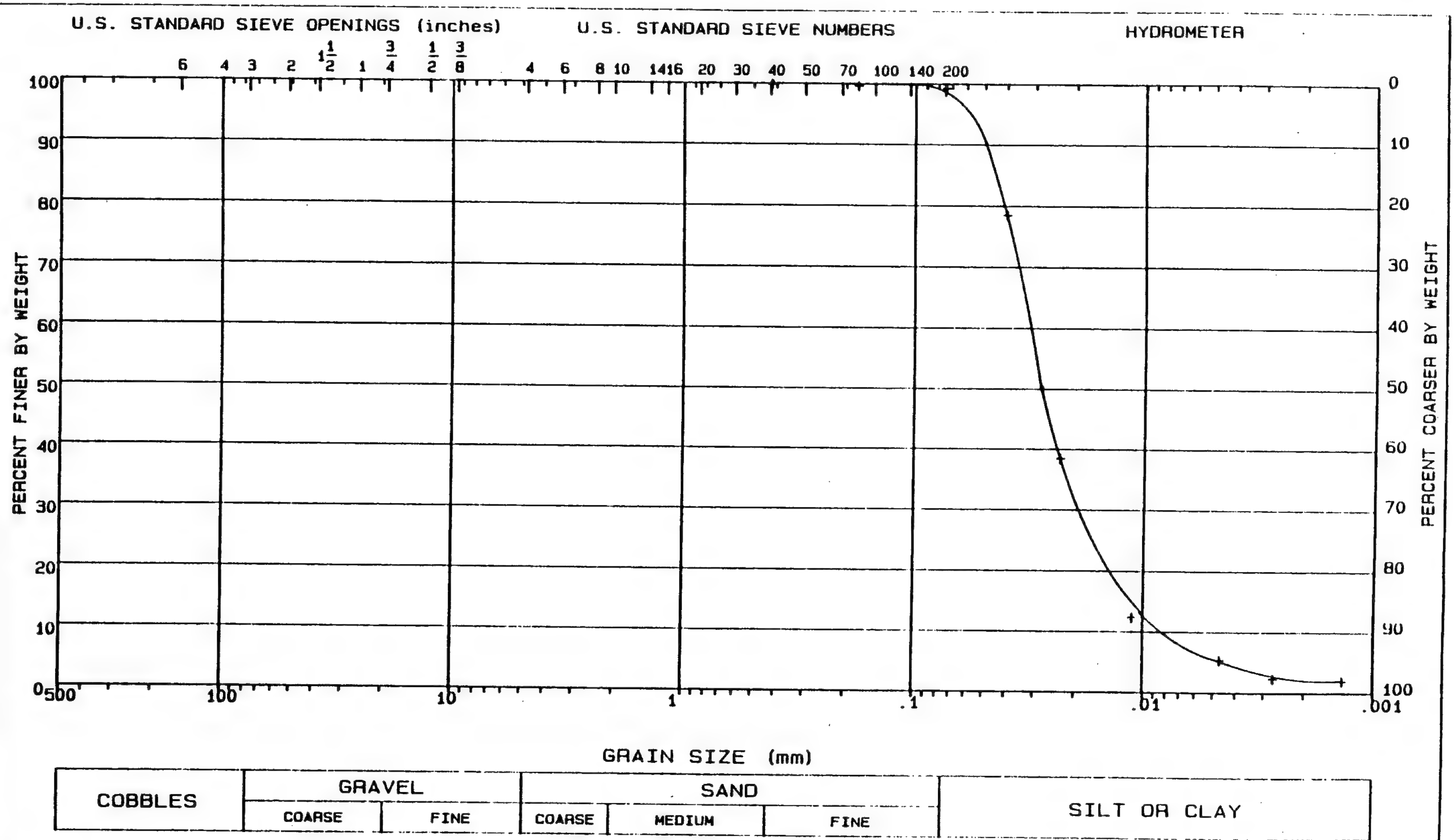
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-7 MU
Sample Number : S-3
Depth : 20'-22'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.632	0.239	1.830	0.380	0.917	0.273
30	0.26	0.929	0.278	2.287	0.300	0.952	0.401
45	0.47	1.130	0.337	2.704	0.299	0.943	0.488
60	0.66	1.275	0.274	2.757	0.215	1.042	0.550
90	1.11	1.618	0.263	3.196	0.163	1.138	0.698
120	1.40	1.981	0.178	3.410	0.090	1.312	0.855
150	1.76	2.339	0.100	3.600	0.043	1.479	1.010
180	2.13	2.694	-0.029	3.617	-0.010	1.696	1.163
210	2.47	3.066	-0.142	3.685	-0.046	1.901	1.323
240	2.84	3.451	-0.249	3.763	-0.072	2.104	1.490
300	3.48	4.256	-0.484	3.867	-0.113	2.538	1.837
360	4.12	5.085	-0.663	4.059	-0.130	2.922	2.195
420	4.81	5.864	-0.912	4.067	-0.155	3.364	2.531
480	5.43	6.672	-1.176	4.066	-0.176	3.828	2.880
[illegible]	6.07	7.431	-1.418	4.073	-0.190	4.258	3.207
6[illegible]	6.75	8.175	-1.674	4.057	-0.204	4.698	3.528
720	8.13	9.714	-2.132	4.101	-0.219	5.537	4.192
840	9.53	11.250	-2.678	4.059	-0.238	6.463	4.856
960	10.92	12.233	-3.126	3.965	-0.255	7.155	5.280

Table 3 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-7 MU
Sample Number : S-3
Depth : 20'-22'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	1.379	0.731	2.086	0.530	1.610	0.595
30	0.26	2.579	1.511	6.269	0.586	1.127	1.113
45	0.48	3.421	2.192	%-16.842	0.641	0.655	1.477
60	0.67	4.012	2.619	-5.484	0.653	0.374	1.732
90	1.13	4.851	3.116	-3.345	0.643	0.085	2.094
120	1.41	5.577	3.196	-3.664	0.574	0.185	2.407
150	1.77	6.212	3.192	-4.210	0.514	0.346	2.681
180	2.15	6.905	3.116	-5.185	0.452	0.594	2.980
210	2.49	7.581	2.993	-6.635	0.395	0.884	3.272
240	2.87	8.280	2.843	-8.823	0.344	1.207	3.574
300	3.52	9.674	2.561	%-16.256	0.265	1.834	4.175
360	4.17	11.096	2.176	%-62.086	0.197	2.571	4.[illegible]
420	4.86	12.603	1.765	54.561	0.141	3.355	5.439
480	5.48	14.082	1.352	22.724	0.096	4.134	6.078
540	6.13	15.427	0.932	15.441	0.061	4.887	6.658
600	6.82	16.867	0.459	11.944	0.028	5.717	7.280
720	8.21	19.447	-0.399	9.107	-0.020	7.214	8.393
840	9.63	21.890	-1.294	7.646	-0.059	8.713	9.448
960	11.04	23.397	-1.717	7.294	-0.073	9.510	10.098



LL = 23	PL = 21	PI = 2	Gs = 2.72	NAT w = %

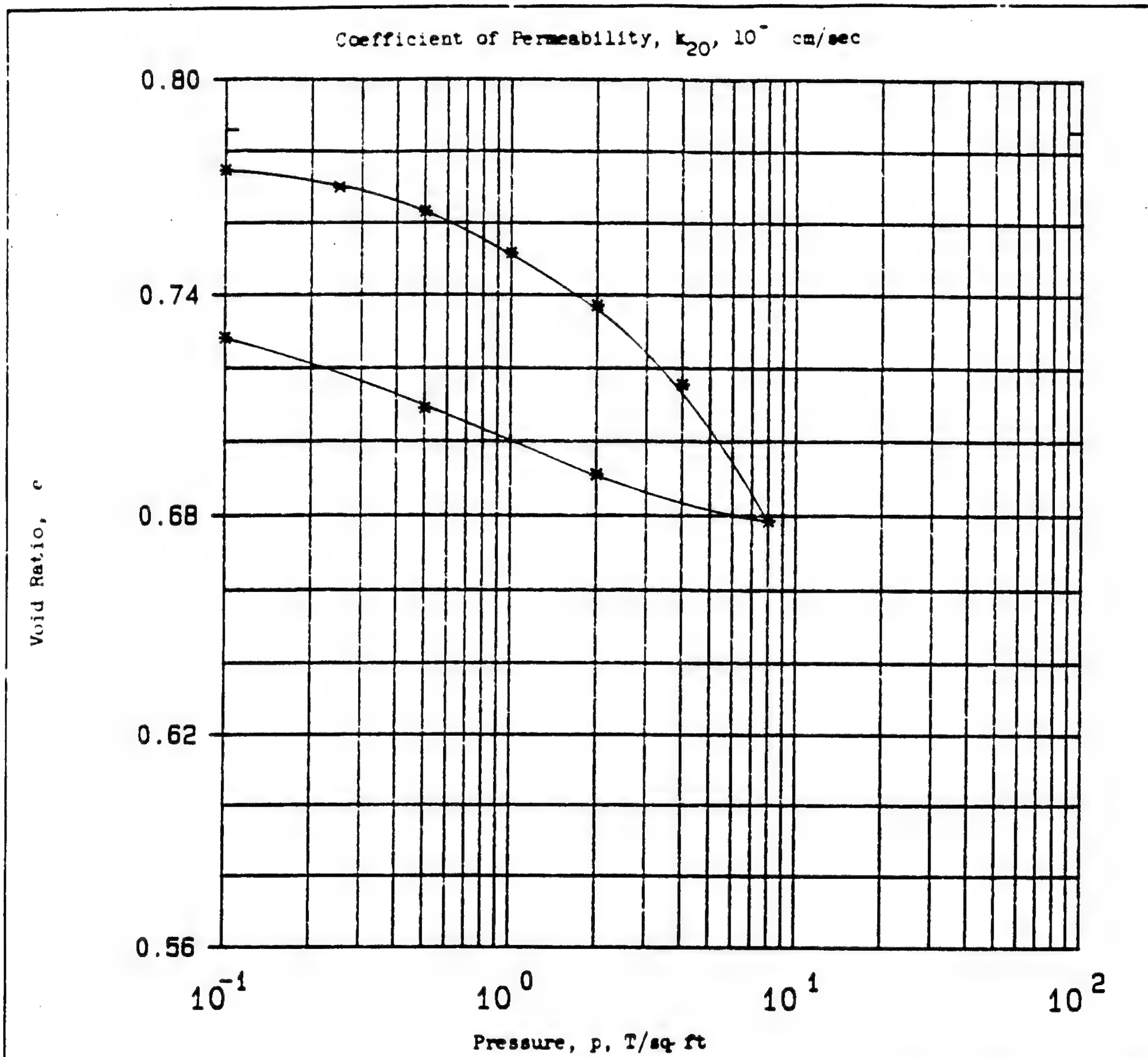
CLASSIFICATION Lean clay, CL

GRADATION CURVE

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

BORING NO. 89-7 MU
SAMPLE NO. S-3
DEPTH/ELEV 20'-22'
MRD LAB NO. 90/_35

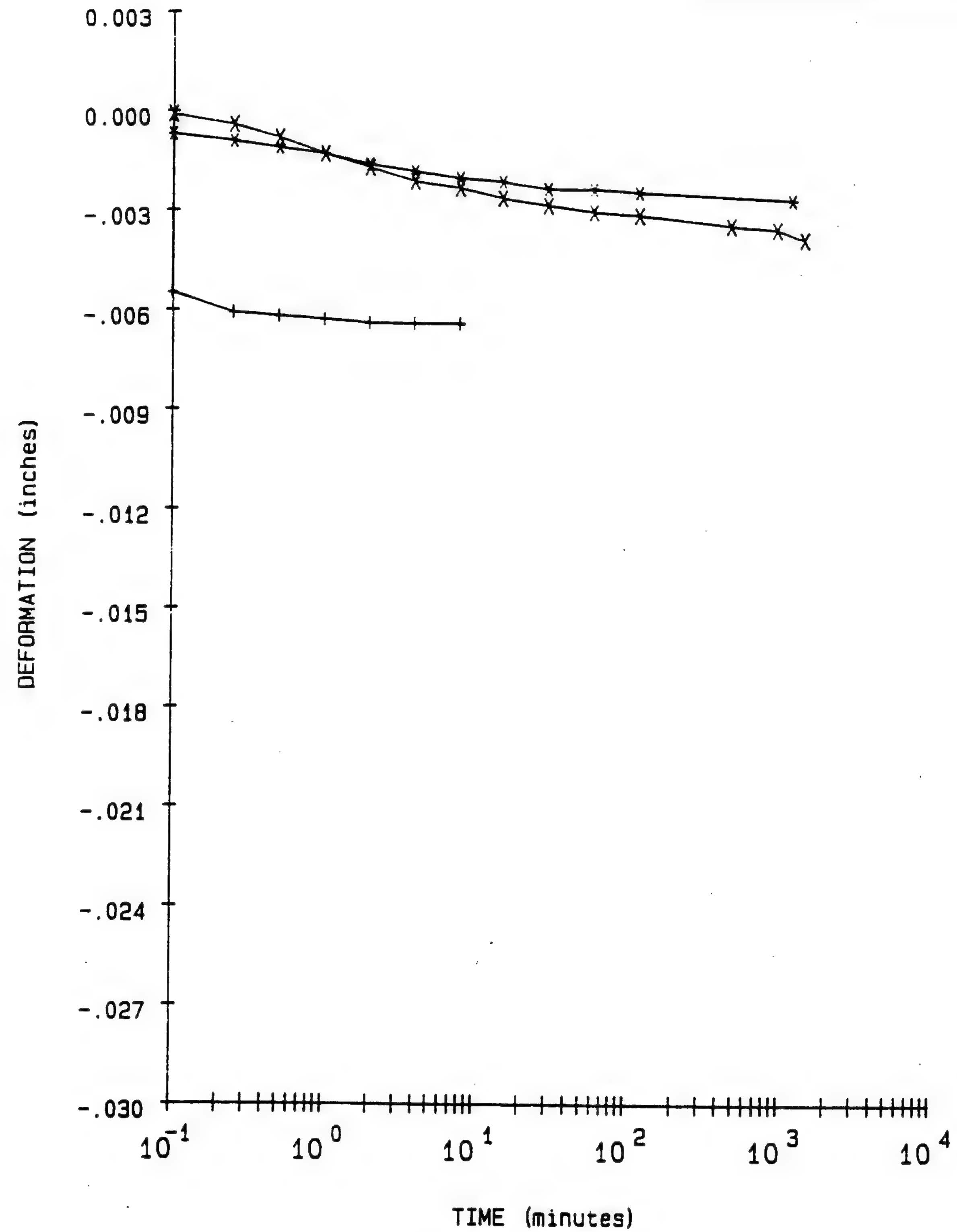
FIGURE 8



Type of Specimen	UNDISTURBED			Before Test		After Test	
Diam 4.4 in.		Ht 1 in.		Water Content, w_o	29.3 %	w_f	27.9 %
Overburden Pressure, p_o			T/sq ft	Void Ratio, e_o	0.79	e_f	0.73
Preconsol. Pressure, p_c			T/sq ft	Saturation, S_o	100 %	S_f	100 %
Compression Index, C_c				Dry Density, γ_d	94.3 lb/ft^3		
Classification Lean clay, CL				k_{20} at e_o = × 10^{-} cm/sec			
LL 47		G_s 2.7		Project	MINNESOTA RIVER; IA-90-04-ED-GH		
PL 19		D_{10}					
Remarks Gray				Area	MRD LAB NO. 90/135		
Torvane=0.65 TSF				Boring No. 89-7 MU		Sample No. S-5	
Calcareous				Depth El 30'-32'		Date	
				CONSOLIDATION TEST REPORT			

ENG FORM 2090 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE.

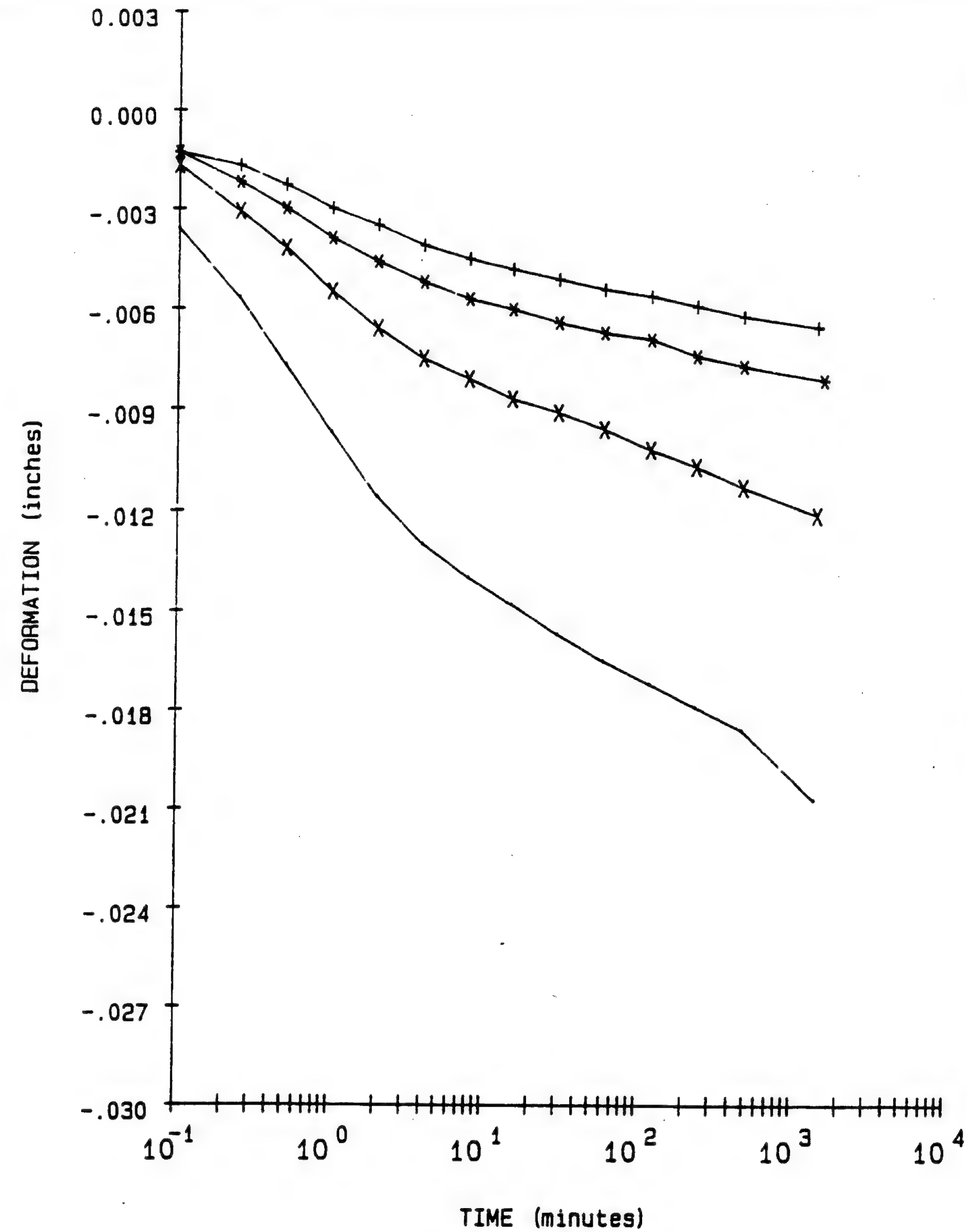
Figure 9



LEGEND	
+ = .1 TSF	
* = .25 TSF	
X = .5 TSF	

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-5
DEPTH/ELEV	30'-32'
MRD LAB NO.	90/135

FIGURE 10

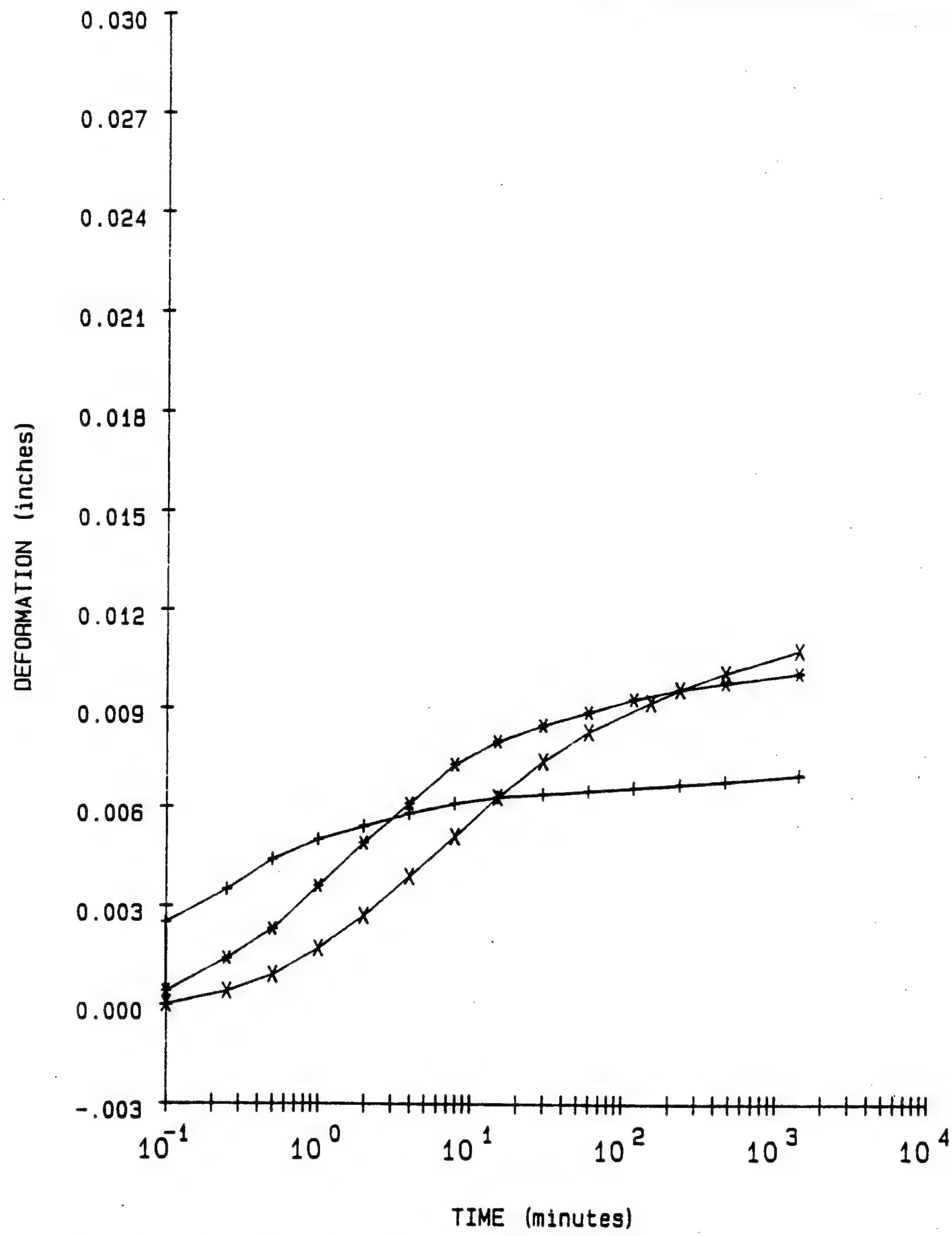


LEGEND		
+ =	1	TSF
* =	2	TSF
X =	4	TSF
- =	8	TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-5
DEPTH/ELEV	30'-32'
MRD LAB NO.	90/135

FIGURE 11

Figure C-302



LEGEND

\+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-5
DEPTH/ELEV	30'-32'
MRD LAB NO.	90/135

FIGURE 12

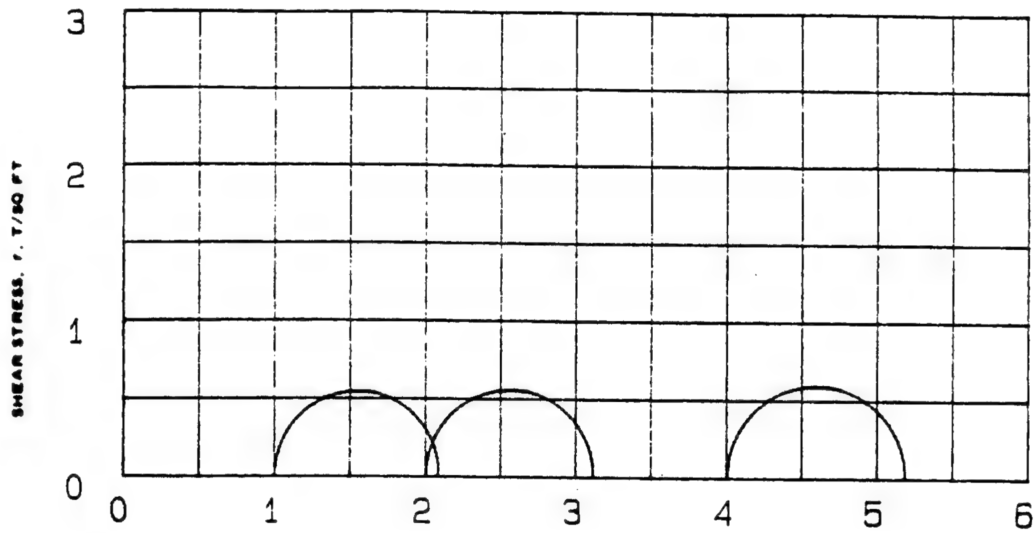
Consolidation Test Data

Project	MINNESOTA RIVER; IA-90-04-ED-GH
Boring No.	89-7 MU
Sample No.	S-5
Depth/Elev	30'-32'
MRD Lab No.	90/135

Gs = 2.7
eo = 0.786
0.42eo = 0.330

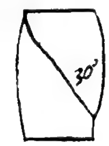
Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
29.3	383.2	94.3	0.786		100.0
27.9	383.2	94.9	0.774	0.10	97.3
27.9	383.2	95.2	0.770	0.25	97.9
27.9	383.2	95.6	0.763	0.50	98.7
27.9	383.2	96.2	0.751	1.00	100.0
27.9	383.2	97.0	0.737	2.00	100.0
27.9	383.2	98.2	0.715	4.00	100.0
27.9	383.2	100.4	0.678	8.00	100.0
27.9	383.2	99.6	0.691	2.00	100.0
27.9	383.2	98.6	0.709	0.50	100.0
27.9	383.2	97.5	0.728	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.768
2	0.750
3	0.732
4	0.714
5	0.697
6	0.679
7	0.661
8	0.643
9	0.625

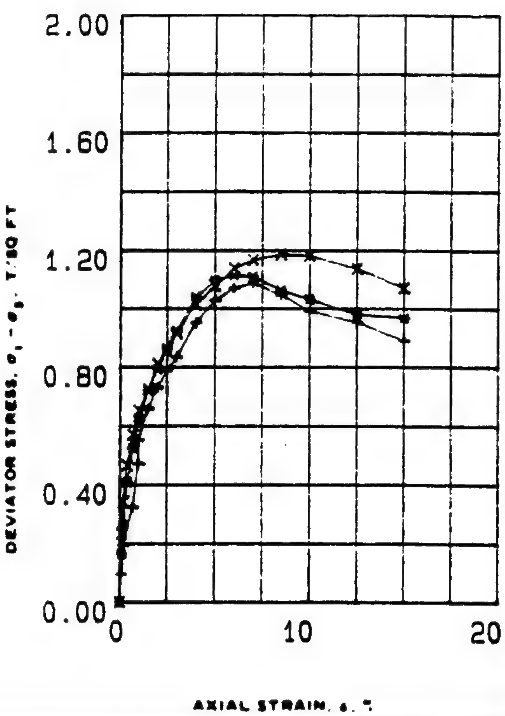


Q-1

Q-2



Q-3



SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	29.5	30.5	29.4	
	DRY DENSITY LB/CU FT	γ_{d_o}	94.2	92.8	94.3	
	SATURATION, %	S_o	100.0	100.0	100.0	
	VOID RATIO	e_o	0.79	0.82	0.79	
BEFORE SHEAR	WATER CONTENT, %	w_c	29.4	30.5	29.6	
	DRY DENSITY LB/CU FT	γ_{d_c}	94.2	92.8	94.7	
	SATURATION, %	S_c	100.0	100.0	100.0	
	VOID RATIO	e_c	0.79	0.82	0.78	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.0	2.0	4.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.09	1.12	1.19	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	15.8	13.5	18.3	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.89	0.97	1.07	
INITIAL DIAMETER, IN.		D_o	1.42	1.42	1.42	
INITIAL HEIGHT, IN.		H_o	3.00	3.02	3.01	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL

LL	PL	PI	G_s	TYPE OF SPECIMEN	TYPE OF TEST
47	19	28	2.7	UNDISTURBED	Q

REMARKS: Gray
Torvane=0.65 TSF
Calcareous

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

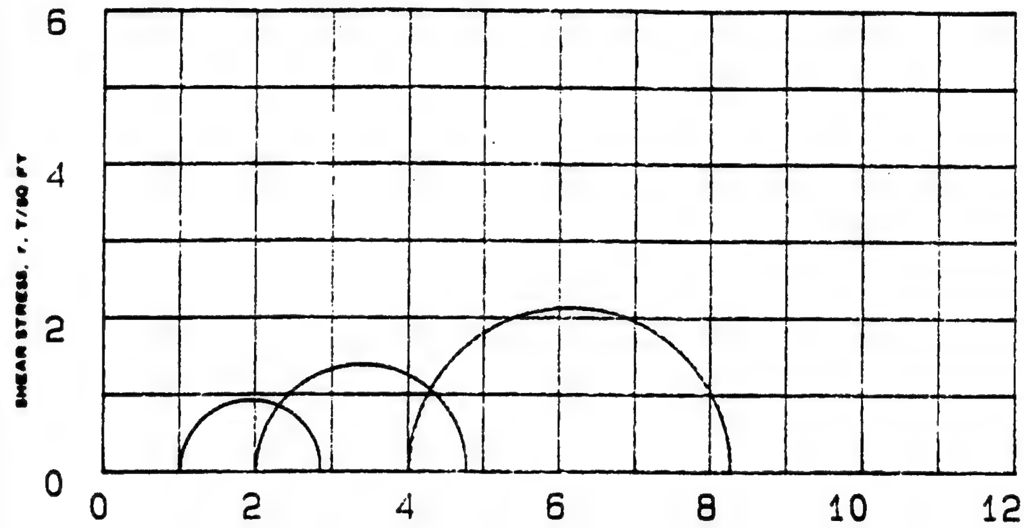
BORING NO 89-7MU — SAMPLE NO. S-5

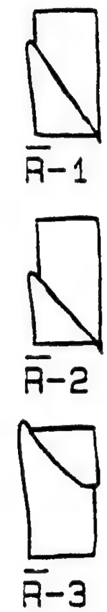
DEPTH ELEV 30'-32'

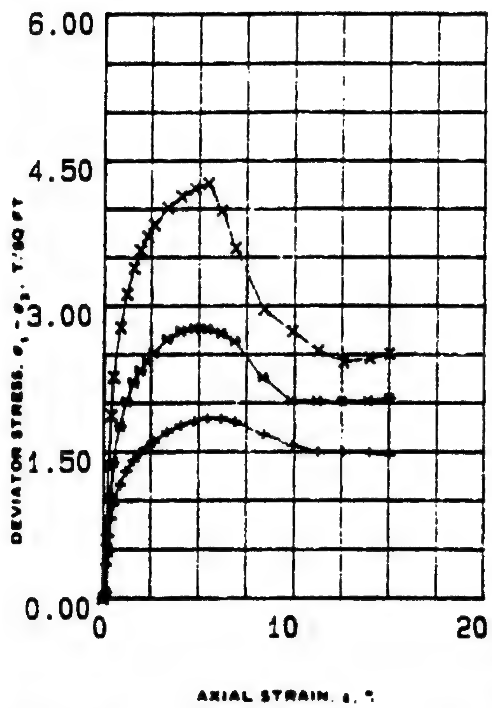
LABORATORY 90/135 — DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 — PREVIOUS EDITION IS OBSOLETE — TRANSLUCENT — (EM 1110-2-1906) — FIGURE 13







NORMAL STRESS, σ, T/SQ FT

SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	28.9	28.1	28.6
	DRY DENSITY LB/CU FT	γd_o	95.5	96.6	95.5
	SATURATION, %	S_o	100	100	100
	VOID RATIO	e_o	.76	.74	.77
BEFORE SHEAR	WATER CONTENT, %	w_c	26.4	27.5	27.8
	DRY DENSITY LB/CU FT	γd_c	98.4	97.3	99.3
	SATURATION, %	S_c	100	100	100
	VOID RATIO	e_c	.71	.73	.7
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1	2	4
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.844	2.768	4.260
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	480	420	480
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.462	2.046	2.502
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.4
INITIAL HEIGHT, IN.		H_o	2.99	2.98	3

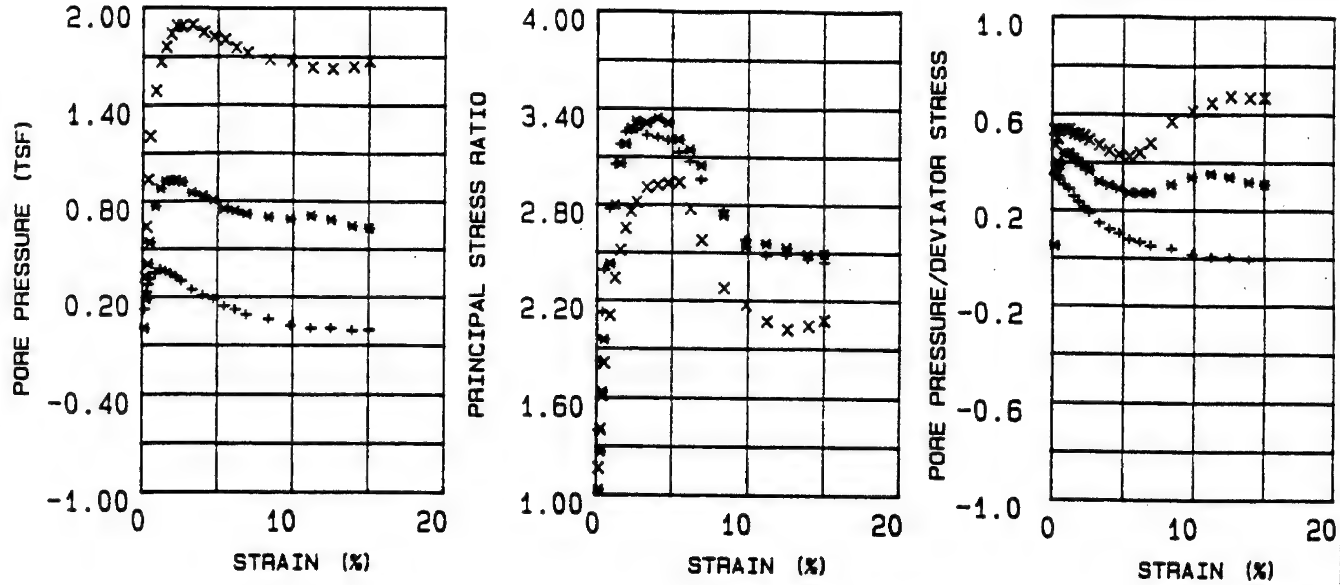
CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL B-value 1.0 1.0 1.0

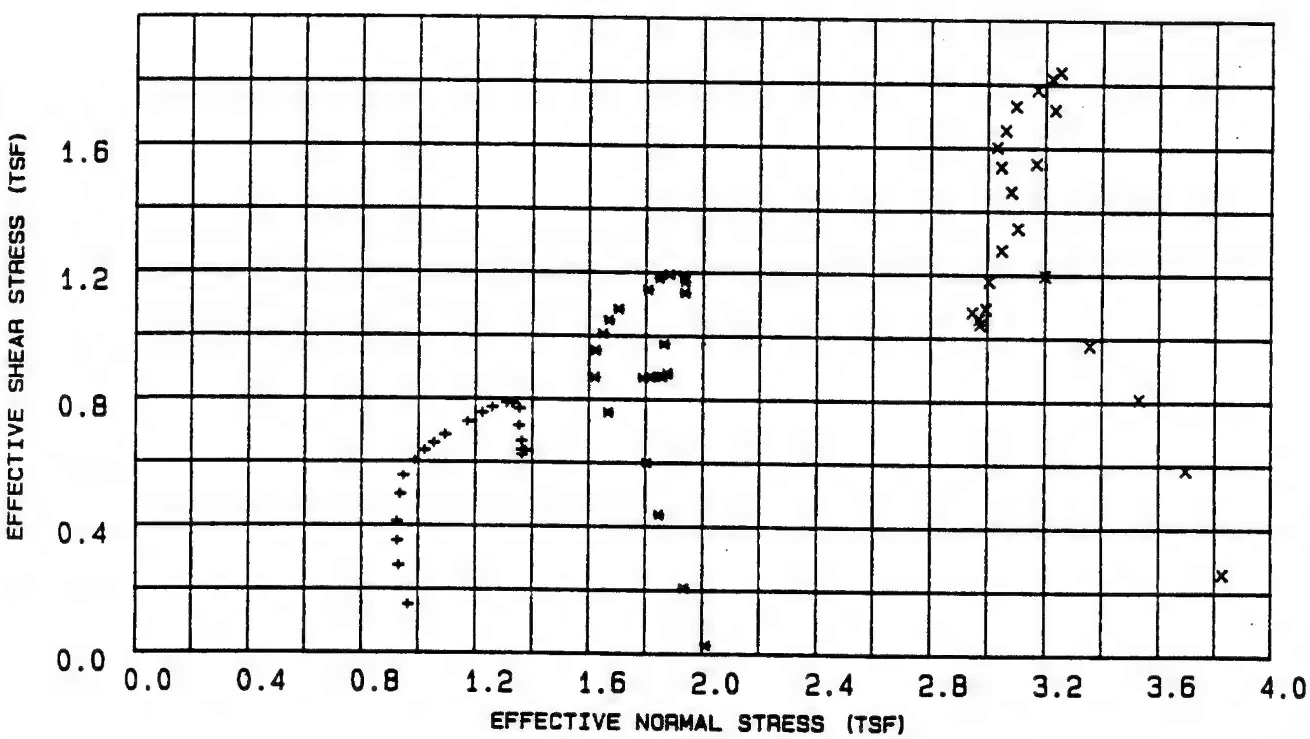
LL 47	PL 19	PI 28	Gs 2.7	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR
REMARKS: Gray				PROJECT MINNESOTA RIVER; IA-90-04-ED-GH	
Torvane=0.65 TSF					
Calcareous				BORING NO. 89-7 MU	SAMPLE NO. S-5
				DEPTH ELEV 30'-32'	
				LABORATORY 90/135	DATE
				TRIAXIAL COMPRESSION TEST REPORT	

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 14



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

\+ = 1 TSF
* = 2 TSF
X = 4 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-5
DEPTH/ELEV	30'-32'
MRD LAB NO.	90/135

FIGURE 15

R

Table 4 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-7 MU
Sample Number : S-5
Depth : 30'-32'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.17	0.349	0.122	1.397	0.350	0.964	0.151
30	0.29	0.635	0.228	1.823	0.360	0.929	0.274
45	0.41	0.813	0.277	2.124	0.341	0.924	0.351
60	0.52	0.954	0.313	2.389	0.328	0.923	0.412
90	0.88	1.153	0.350	2.774	0.304	0.935	0.498
120	1.22	1.289	0.372	3.053	0.289	0.947	0.556
150	1.57	1.396	0.359	3.177	0.257	0.987	0.603
180	1.90	1.477	0.345	3.254	0.234	1.021	0.637
210	2.26	1.530	0.325	3.265	0.213	1.054	0.660
240	2.62	1.591	0.300	3.274	0.189	1.094	0.687
300	3.31	1.687	0.245	3.234	0.146	1.173	0.728
360	4.03	1.754	0.210	3.220	0.120	1.224	0.757
420	4.71	1.795	0.185	3.202	0.103	1.259	0.775
[illegible]	5.43	1.826	0.142	3.129	0.078	1.310	0.788
[illegible]	6.15	1.823	0.120	3.071	0.066	1.331	0.787
600	6.88	1.784	0.088	2.957	0.050	1.354	0.770
720	8.36	1.660	0.060	2.766	0.037	1.351	0.716
840	9.81	1.546	0.021	2.580	0.014	1.362	0.667
960	11.17	1.478	0.004	2.484	0.003	1.362	0.638
1080	12.50	1.482	0.004	2.489	0.003	1.363	0.640
1200	13.89	1.476	-0.010	2.463	-0.006	1.376	0.637
1292	15.00	1.447	-0.005	2.440	-0.003	1.363	0.624

Table 5 - Triaxial $\overline{R}$ Test Results

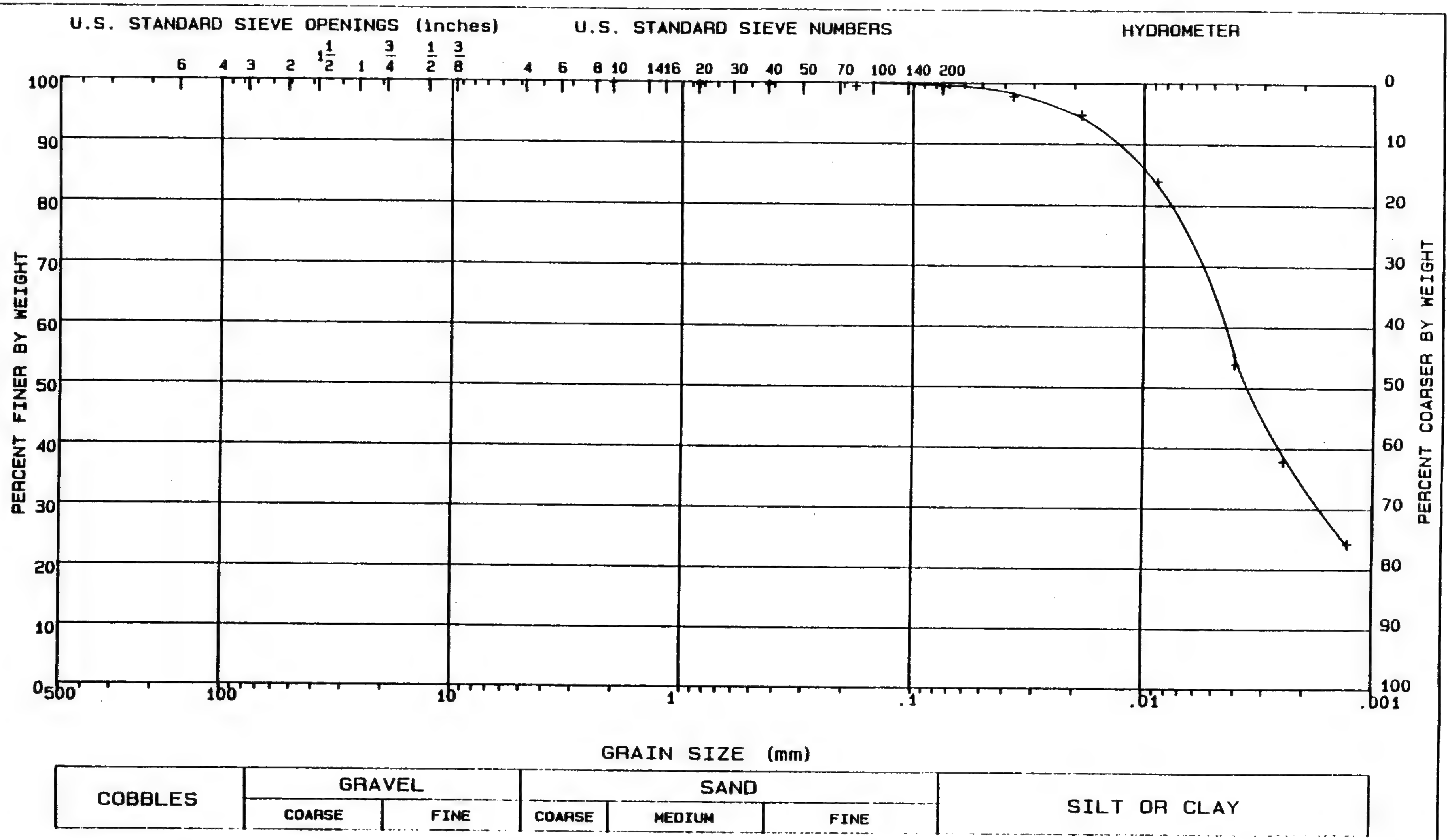
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-7 MU
Sample Number : S-5
Depth : 30'-32'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.17	0.062	0.003	1.031	0.050	2.012	0.027
30	0.29	0.480	0.184	1.265	0.383	1.935	0.207
45	0.41	1.012	0.405	1.634	0.401	1.846	0.437
60	0.52	1.390	0.541	1.953	0.390	1.803	0.600
90	0.88	1.761	0.768	2.429	0.437	1.668	0.760
120	1.22	2.016	0.879	2.798	0.436	1.620	0.870
150	1.57	2.212	0.925	3.057	0.418	1.623	0.955
180	1.91	2.333	0.929	3.179	0.399	1.649	1.007
210	2.26	2.433	0.932	3.279	0.384	1.670	1.050
240	2.62	2.514	0.919	3.325	0.366	1.703	1.085
300	3.31	2.656	0.851	3.312	0.321	1.807	1.146
360	4.03	2.740	0.831	3.344	0.304	1.847	1.182
420	4.72	2.768	0.802	3.311	0.290	1.883	1.195
480	5.43	2.759	0.750	3.207	0.272	1.933	1.191
[illegible]	6.15	2.713	0.736	3.146	0.272	1.936	1.171
[illegible]	6.89	2.631	0.715	3.047	0.272	1.936	1.136
720	8.36	2.260	0.695	2.731	0.308	1.864	0.975
840	9.82	2.020	0.685	2.537	0.340	1.815	0.872
960	11.18	2.011	0.708	2.557	0.353	1.790	0.868
1080	12.51	2.017	0.682	2.531	0.339	1.817	0.871
1200	13.89	2.021	0.643	2.489	0.318	1.857	0.872
1291	15.00	2.046	0.631	2.494	0.309	1.875	0.883

Table 6 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-7 MU
Sample Number : S-5
Depth : 30'-32'
Confining Pressure : 4 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.17	0.600	0.321	1.163	0.535	3.827	0.259
30	0.29	1.355	0.638	1.403	0.471	3.697	0.585
45	0.41	1.874	0.933	1.611	0.499	3.531	0.809
60	0.53	2.266	1.204	1.811	0.532	3.357	0.978
90	0.89	2.774	1.488	2.104	0.537	3.199	1.197
120	1.22	3.119	1.667	2.337	0.535	3.105	1.346
150	1.58	3.388	1.758	2.512	0.519	3.081	1.462
180	1.92	3.569	1.838	2.650	0.515	3.046	1.540
210	2.28	3.711	1.888	2.757	0.509	3.031	1.602
240	2.64	3.835	1.888	2.815	0.493	3.061	1.655
300	3.33	4.010	1.896	2.906	0.473	3.097	1.731
360	4.05	4.129	1.850	2.921	0.449	3.172	1.782
420	4.74	4.213	1.821	2.933	0.433	3.222	1.818
480	5.46	4.260	1.804	2.940	0.424	3.251	1.83[illegible]
[illegible]	6.18	3.983	1.754	2.773	0.441	3.232	1.719
[illegible]	6.93	3.590	1.721	2.575	0.480	3.168	1.550
720	8.41	2.955	1.683	2.276	0.570	3.049	1.276
840	9.87	2.730	1.671	2.172	0.612	3.005	1.178
960	11.24	2.531	1.633	2.069	0.646	2.994	1.092
1080	12.58	2.416	1.625	2.017	0.673	2.973	1.043
1200	13.97	2.456	1.638	2.040	0.667	2.970	1.060
1284	15.00	2.502	1.673	2.075	0.669	2.946	1.080



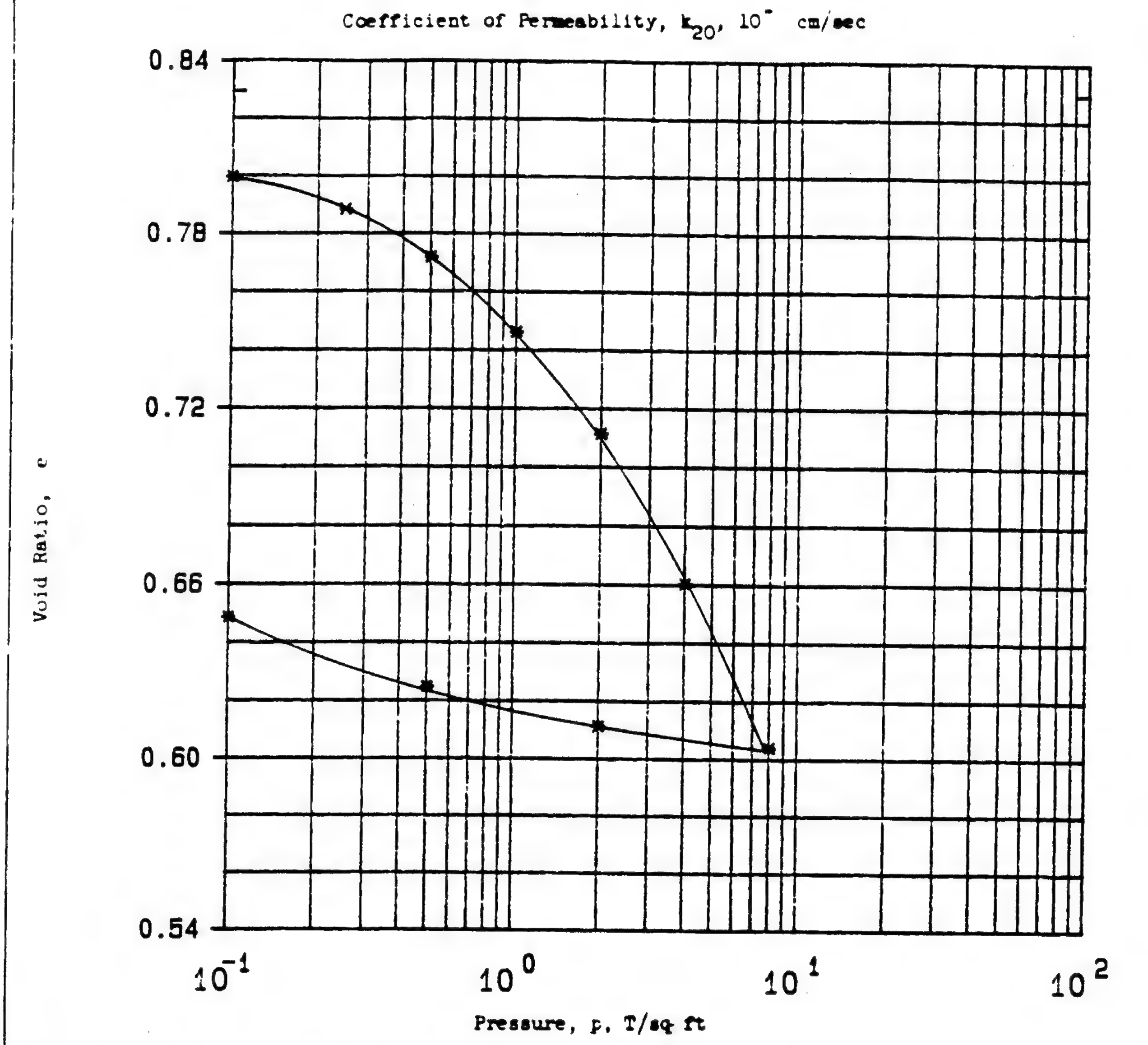
LL = 47	PL = 19	PI = 28	Gs = 2.7	NAT w = %

CLASSIFICATION Lean clay, CL

GRADATION CURVE

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-7 MU
SAMPLE NO.	S-5
DEPTH/ELEV	30'-32'
MRD LAB NO.	90/135

FIGURE 16



Type of Specimen	UNDISTURBED		Before Test		After Test	
Diam 4.4 in.	Ht 1 in.		Water Content, w_o	31.5 %	w_f	26.0 %
Overburden Pressure, p_o		T/sq ft	Void Ratio, e_o	0.83	e_f	0.65
Preconsol. Pressure, p_c		T/sq ft	Saturation, S_o	100 %	S_f	100 %
Compression Index, C_c			Dry Density, γ_d	90.4 lb/ft^3		
Classification	Sandy clay, CL		k_{20} at e_o =	$\times 10^{-}$ cm/sec		

LL 44	G_s 2.65
PL 23	D_{10}

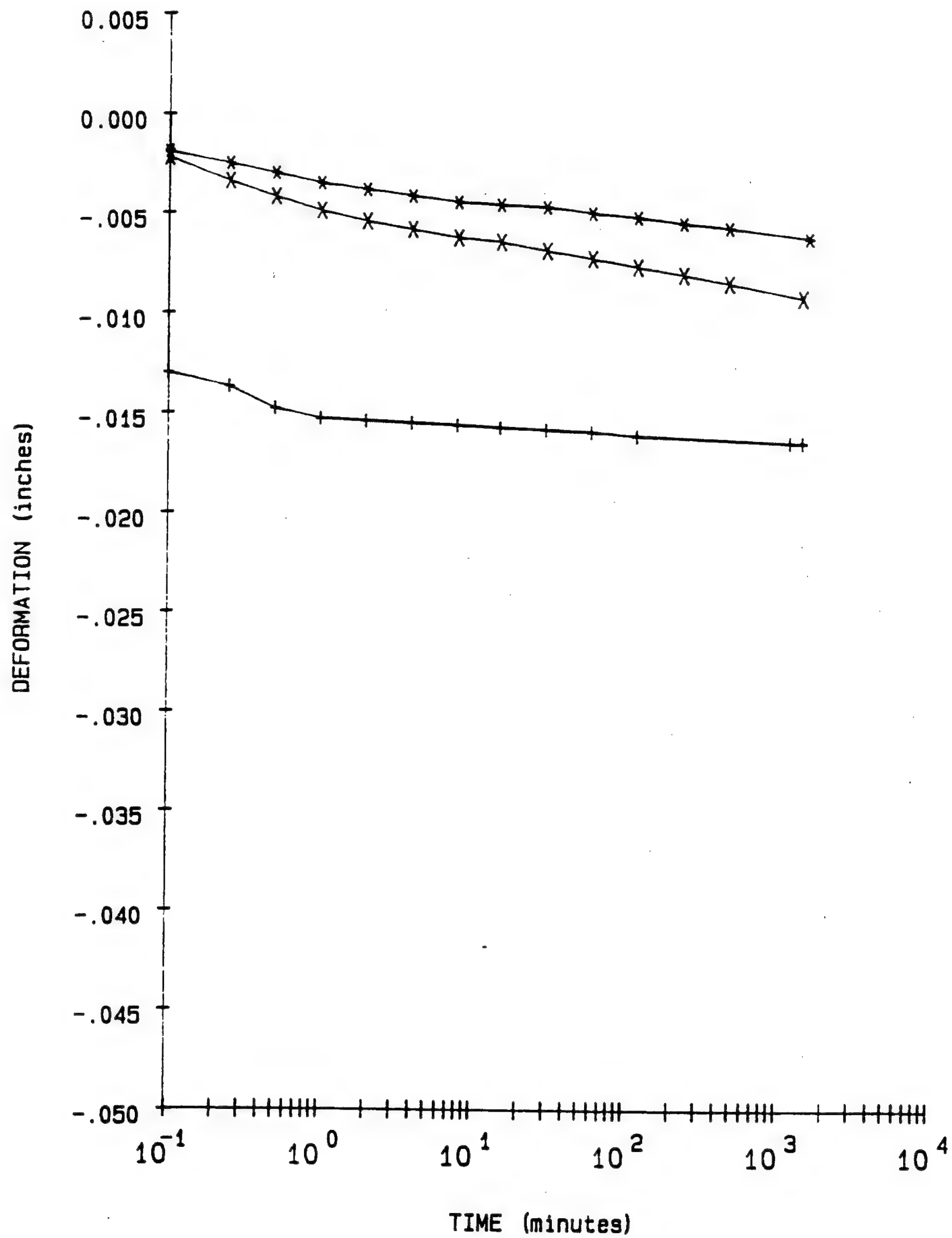
Project	MINNESOTA RIVER: IA-90-04-ED-GH
Area	MRD LAB NO. 90/135
Boring No. 89-106 MU	Sample No. S-1
Depth El 29'-31'	Date

Remarks Dark gray-black, organic, no Torvane. Slightly calcareous.

CONSOLIDATION TEST REPORT

ENG FORM 2090 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 17

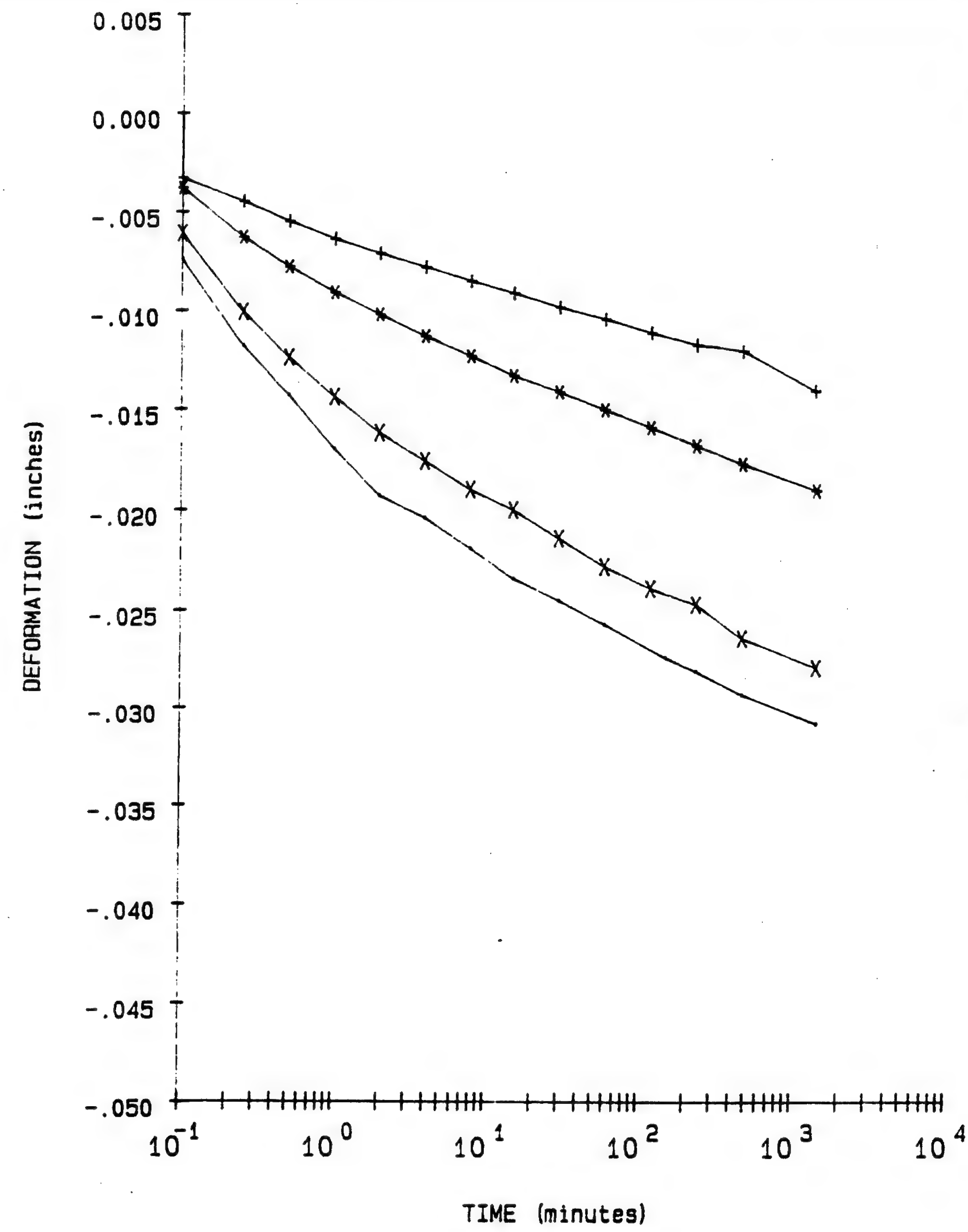


LEGEND

+ = .1 TSF
* = .25 TSF
X = .5 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-106 MU
SAMPLE NO.	S-1
DEPTH/ELEV	29'-31'
MRD LAB NO.	90/135

FIGURE 18

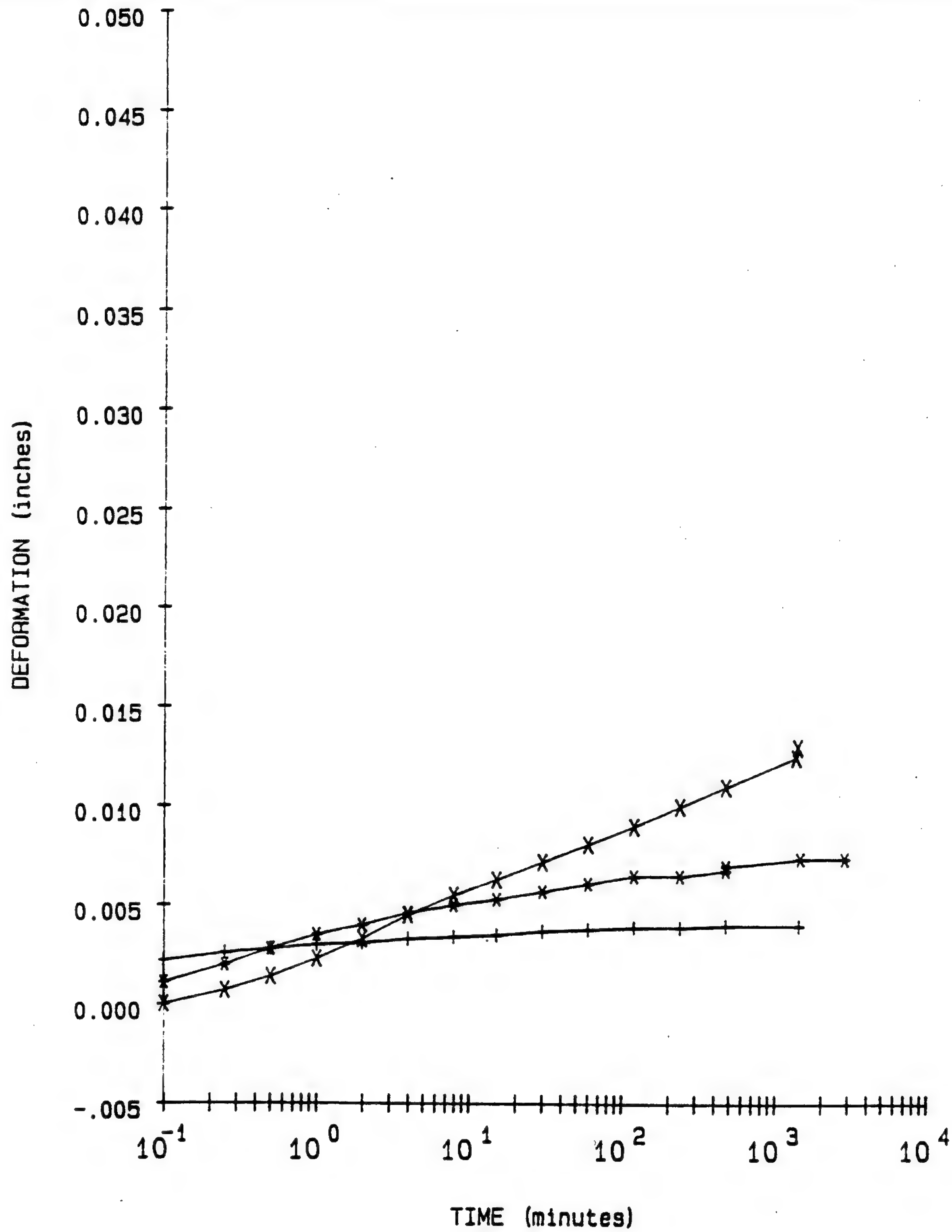


LEGEND

\+ = 1 TSF
* = 2 TSF
X = 4 TSF
\- = 8 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-108 MU
SAMPLE NO.	S-1
DEPTH/ELEV	29'-31'
MRD LAB NO.	90/135

FIGURE 19



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-106 MU
SAMPLE NO.	S-1
DEPTH/ELEV	29'-31'
MRD LAB NO.	90/135

FIGURE 20

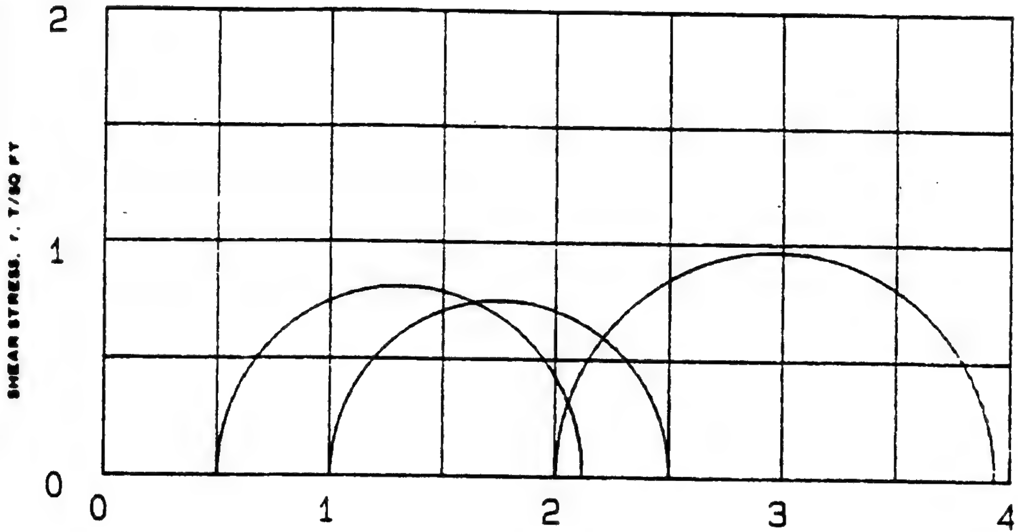
Consolidation Test Data

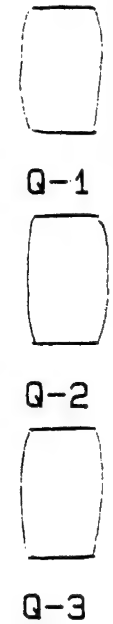
Project	MINNESOTA RIVER; IA-90-04-ED-GH
Boring No.	89-106 MU
Sample No.	S-1
Depth/Elev	29'-31'
MRD Lab No.	90/135

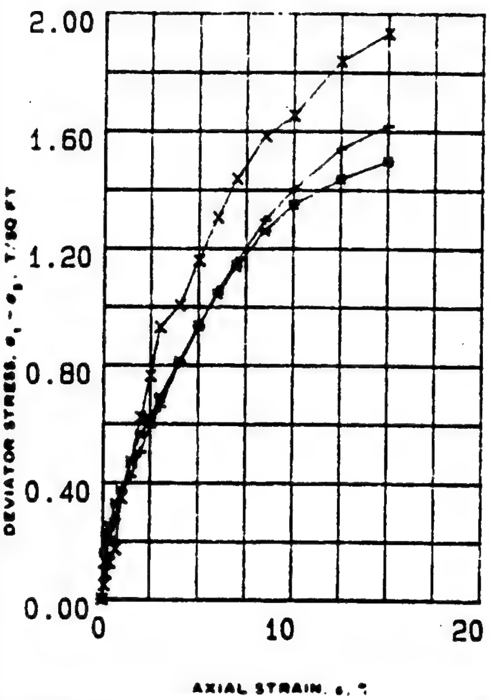
Gs = 2.65
eo = 0.829
0.42eo = 0.348

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
31.5	367.2	90.4	0.829		100.0
26.0	367.2	91.9	0.799	0.10	86.2
26.0	367.2	92.5	0.788	0.25	87.4
26.0	367.2	93.3	0.772	0.50	89.3
26.0	367.2	94.7	0.746	1.00	92.3
26.0	367.2	96.6	0.711	2.00	96.8
26.0	367.2	99.6	0.660	4.00	100.0
26.0	367.2	103.1	0.604	8.00	100.0
26.0	367.2	102.6	0.611	2.00	100.0
26.0	367.2	101.8	0.625	0.50	100.0
26.0	367.2	100.3	0.649	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.811
2	0.793
3	0.775
4	0.756
5	0.738
6	0.720
7	0.701
8	0.683
9	0.665
10	0.647
11	0.628
12	0.610
13	0.592
14	0.573
15	0.555







SPECIMEN NO.			1 (+)	2 (x)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	25.8	27.3	26.2	
	DRY DENSITY LB/CU FT	γ_{d_o}	99.1	96.5	98.8	
	SATURATION, %	S_o	100.0	100.0	100.0	
	VOID RATIO	e_o	0.67	0.71	0.67	
BEFORE SHEAR	WATER CONTENT, %	w_c	25.7	27.1	26.1	
	DRY DENSITY LB/CU FT	γ_{d_c}	99.1	96.8	99.2	
	SATURATION, %	S_c	100.0	100.0	100.0	
	VOID RATIO	e_c	0.67	0.71	0.67	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.62	1.50	1.93	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	28.0	28.3	30.0	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.62	1.50	1.93	
INITIAL DIAMETER, IN.		D_o	1.41	1.41	1.41	
INITIAL HEIGHT, IN.		H_o	2.96	2.96	2.96	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CL

LL 44	PL 23	PI 21	G_s 2.65	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Dark gray-black, organic, no Torvane. Slightly calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-5D-GH

BORING NO 89-106 MU

SAMPLE NO. S-1

DEPTH ELEV 29'-31'

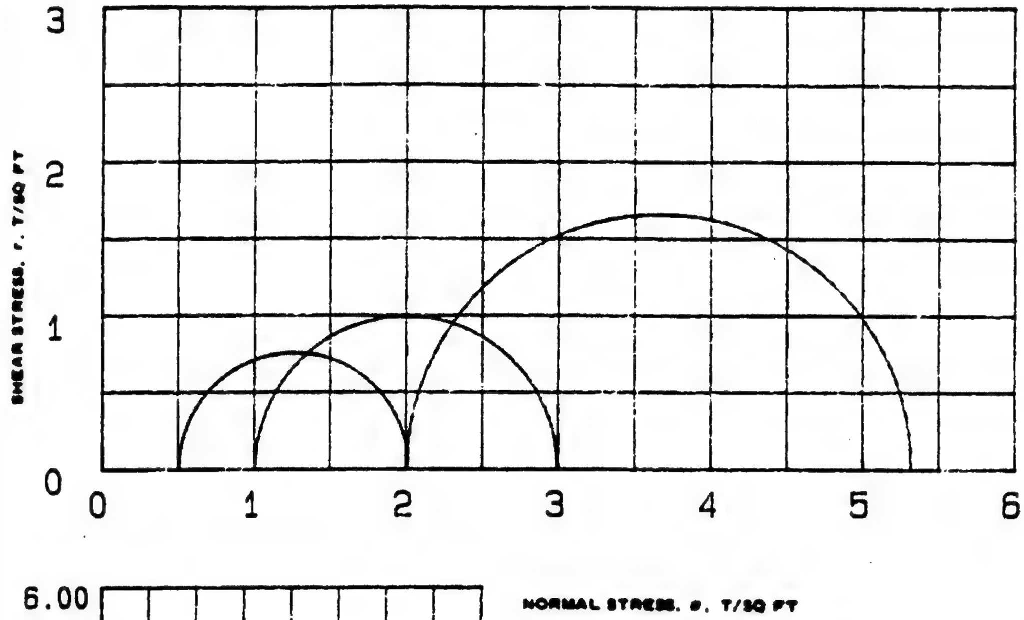
LABORATORY 90/135

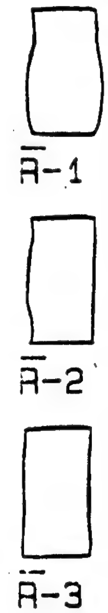
DATE

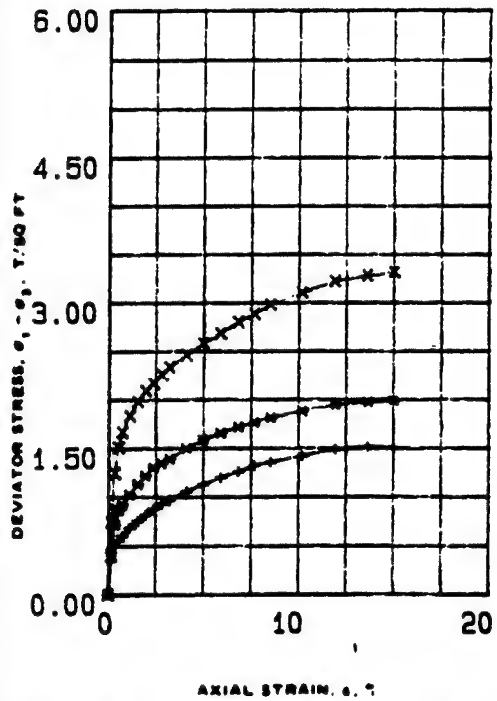
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 21







	SPECIMEN NO.		1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	30.7	30.5	29.6
	DRY DENSITY LB/CU FT	γ_{d_o}	91.6	92.1	93.2
	SATURATION, %	S_o	100	100	100
	VOID RATIO	e_o	.81	.8	.77
BEFORE SHEAR	WATER CONTENT, %	w_c	28.6	27.3	25.8
	DRY DENSITY LB/CU FT	γ_{d_c}	94	96	98.2
	SATURATION, %	S_c	100	100	100
	VOID RATIO	e_c	.76	.72	.68
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.543	5.543	5.543
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.510	1.989	3.315
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	960	1047	1051
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.500	1.989	3.315
INITIAL DIAMETER, IN.		D_o	1.41	1.41	1.39
INITIAL HEIGHT, IN.		H_o	2.95	2.96	2.98

CONTROLLED- STRAIN TEST

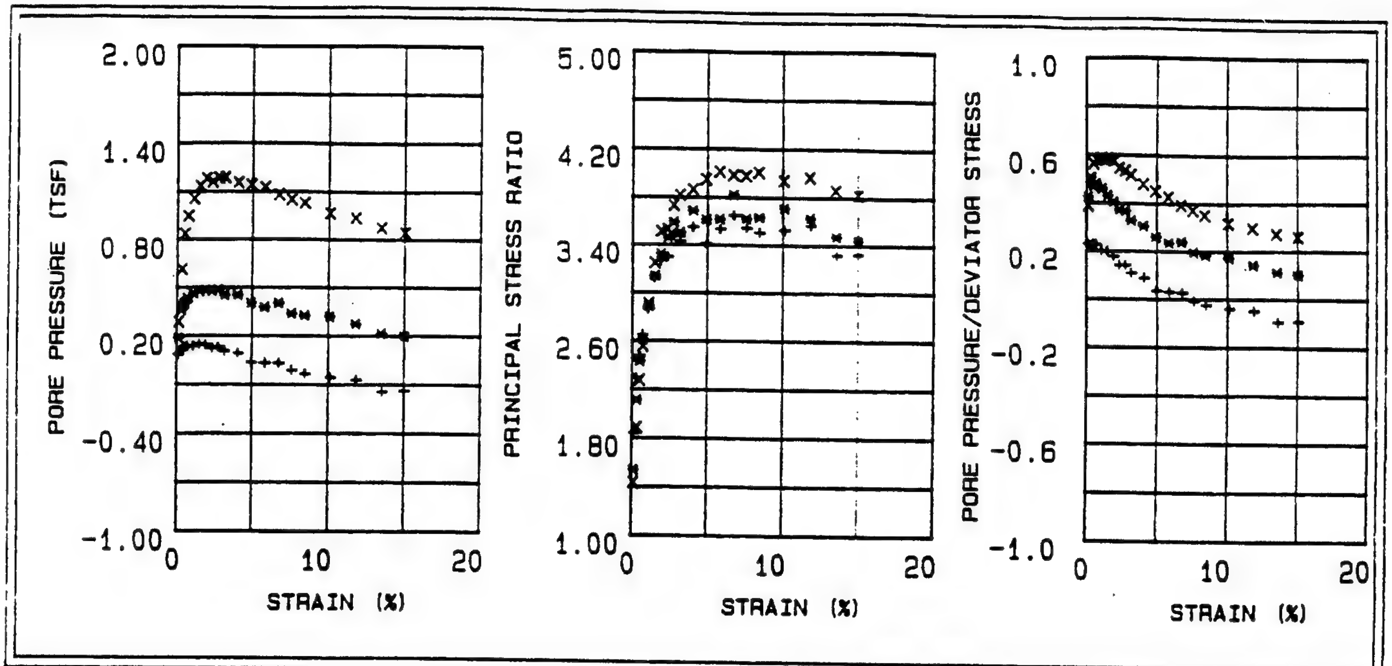
DESCRIPTION OF SPECIMENS Sandy clay, CL B-value 1.0 1.0 1.0

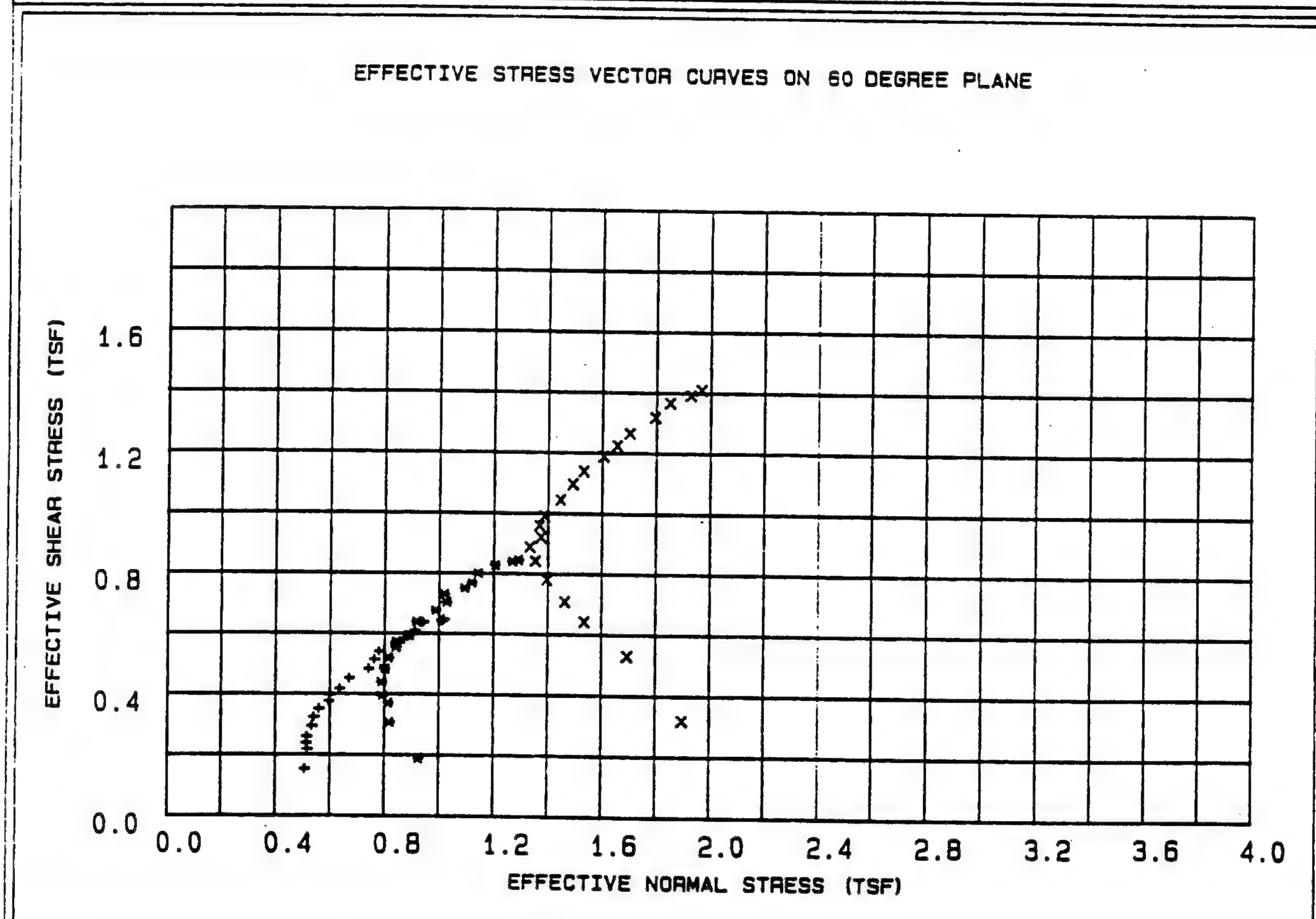
LL 44	PL 23	PI 21	G_s 2.65	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Dark gray and black	PROJECT MINNESOTA RIVER: IA-90-04-ED-6H
Organic	
No Torvane	BORING NO. 89-106 MU — SAMPLE NO. S-1
Slightly calcareous	DEPTH ELEV 29'-31'
	LABORATORY 90/135 — DATE
	TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 22





LEGEND

+ = .5 TSF
✱ = 1 TSF
X = 2 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-106 MU
SAMPLE NO.	S-1
DEPTH/ELEV	29'-31'
MRD LAB NO.	90/135

FIGURE 23

C
R

Table 7 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-106 MU
Sample Number : S-1
Depth : 29'-31'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.15	0.351	0.080	1.836	0.227	0.507	0.152
30	0.34	0.503	0.109	2.289	0.218	0.516	0.217
45	0.54	0.552	0.125	2.473	0.227	0.512	0.238
60	0.73	0.600	0.135	2.644	0.225	0.514	0.259
90	1.12	0.680	0.135	2.861	0.199	0.533	0.293
120	1.53	0.749	0.146	3.120	0.196	0.540	0.323
150	1.95	0.810	0.142	3.264	0.176	0.559	0.350
180	2.36	0.870	0.121	3.296	0.140	0.594	0.375
210	2.78	0.921	0.128	3.479	0.140	0.600	0.397
240	3.19	0.963	0.103	3.426	0.107	0.635	0.416
300	4.07	1.046	0.089	3.545	0.086	0.670	0.451
360	4.95	1.118	0.035	3.404	0.032	0.742	0.482
420	5.85	1.188	0.031	3.532	0.026	0.763	0.51[illegible]
4[illegible]	6.77	1.248	0.029	3.647	0.023	0.780	0.539
5[illegible]	7.60	1.309	-0.015	3.541	-0.011	0.839	0.565
600	8.46	1.343	-0.037	3.501	-0.027	0.870	0.580
720	10.11	1.412	-0.059	3.524	-0.042	0.909	0.609
840	11.84	1.474	-0.075	3.562	-0.051	0.940	0.636
960	13.55	1.496	-0.146	3.314	-0.097	1.016	0.646
1054	15.00	1.485	-0.140	3.322	-0.094	1.007	0.641

Table 3 - Triaxial $\overline{R}$ Test Results

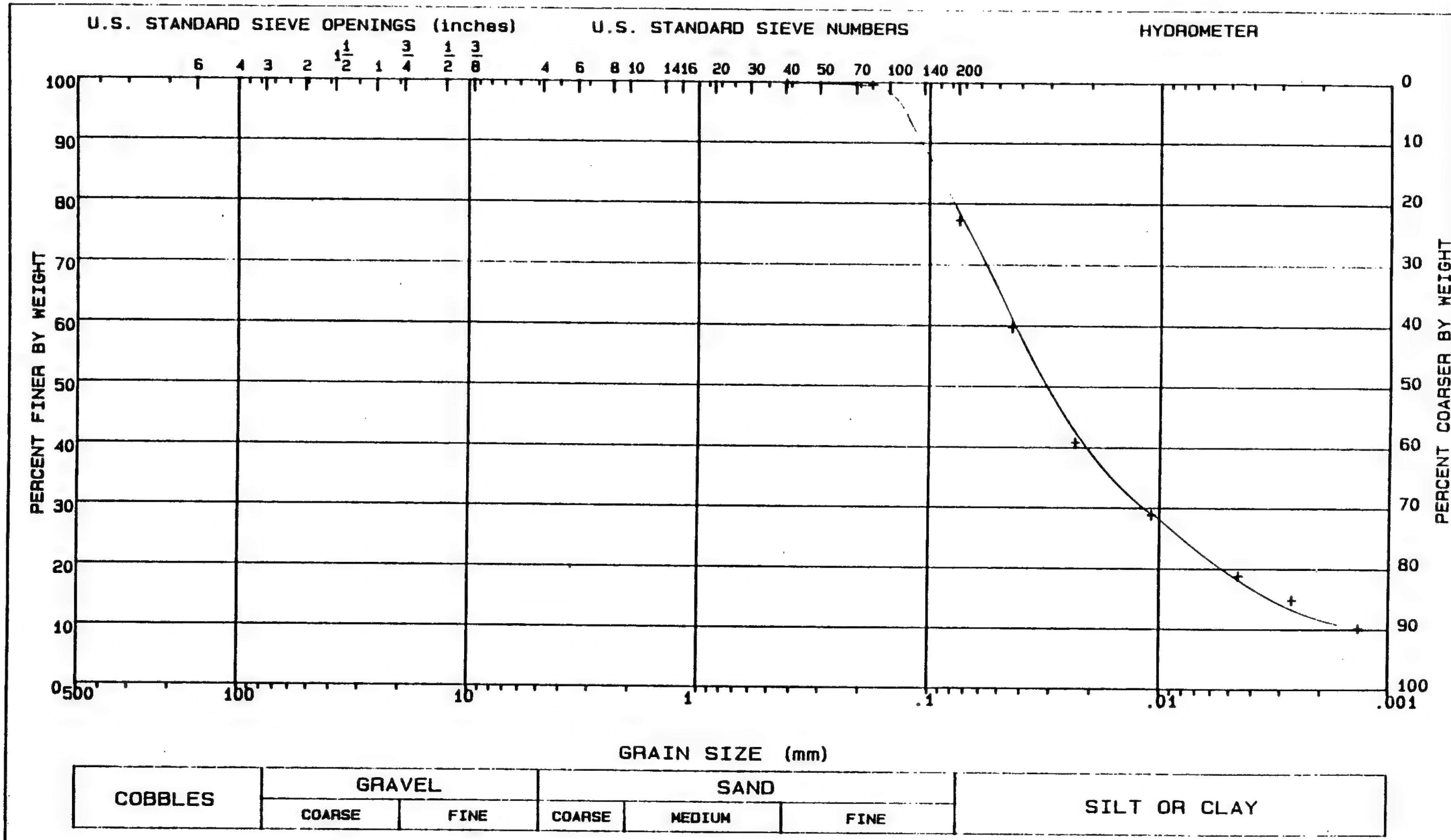
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-106 MU
Sample Number : S-1
Depth : 29'-31'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.15	0.434	0.184	1.532	0.423	0.924	0.187
30	0.34	0.712	0.358	2.110	0.504	0.818	0.307
45	0.54	0.858	0.399	2.428	0.465	0.813	0.370
60	0.73	0.911	0.434	2.608	0.477	0.791	0.393
90	1.12	1.015	0.462	2.887	0.456	0.789	0.438
120	1.53	1.117	0.477	3.138	0.428	0.800	0.482
150	1.94	1.201	0.483	3.324	0.403	0.814	0.518
180	2.36	1.283	0.477	3.455	0.372	0.841	0.554
210	2.77	1.329	0.486	3.587	0.367	0.843	0.573
240	3.18	1.374	0.450	3.499	0.328	0.890	0.593
300	4.05	1.479	0.449	3.683	0.304	0.917	0.638
360	4.93	1.564	0.401	3.609	0.257	0.986	0.675
420	5.83	1.629	0.376	3.613	0.232	1.027	0.703
480	6.75	1.692	0.401	3.822	0.237	1.018	0.730
[illegible]	7.58	1.738	0.336	3.617	0.194	1.094	0.750
600	8.43	1.783	0.322	3.630	0.181	1.119	0.769
720	10.08	1.852	0.316	3.709	0.171	1.143	0.800
840	11.80	1.916	0.270	3.623	0.141	1.204	0.827
960	13.50	1.943	0.212	3.467	0.110	1.269	0.839
1057	15.00	1.959	0.195	3.435	0.100	1.290	0.846

Table 9 - Triaxial $\overline{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-106 MU
Sample Number : S-1
Depth : 29'-31'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.15	0.736	0.283	1.429	0.386	1.899	0.318
30	0.34	1.226	0.610	1.882	0.498	1.694	0.529
45	0.53	1.486	0.833	2.273	0.561	1.535	0.641
60	0.73	1.639	0.944	2.552	0.577	1.462	0.707
90	1.12	1.804	1.053	2.906	0.584	1.394	0.779
120	1.52	1.949	1.131	3.244	0.581	1.352	0.841
150	1.94	2.059	1.179	3.508	0.573	1.331	0.888
180	2.35	2.132	1.156	3.527	0.543	1.372	0.920
210	2.76	2.222	1.184	3.725	0.533	1.366	0.959
240	3.17	2.295	1.184	3.813	0.517	1.384	0.990
300	4.04	2.418	1.154	3.860	0.478	1.445	1.044
360	4.91	2.539	1.138	3.946	0.449	1.491	1.096
420	5.81	2.640	1.123	4.010	0.426	1.531	1.139
480	6.73	2.754	1.077	3.982	0.391	1.605	1.18[illegible]
[illegible]	7.55	2.836	1.047	3.975	0.370	1.655	1.224
600	8.40	2.931	1.025	4.007	0.350	1.701	1.265
720	10.05	3.053	0.961	3.937	0.315	1.795	1.318
840	11.76	3.164	0.933	3.964	0.295	1.850	1.366
960	13.46	3.224	0.871	3.856	0.271	1.927	1.392
1060	15.00	3.264	0.842	3.819	0.258	1.966	1.409



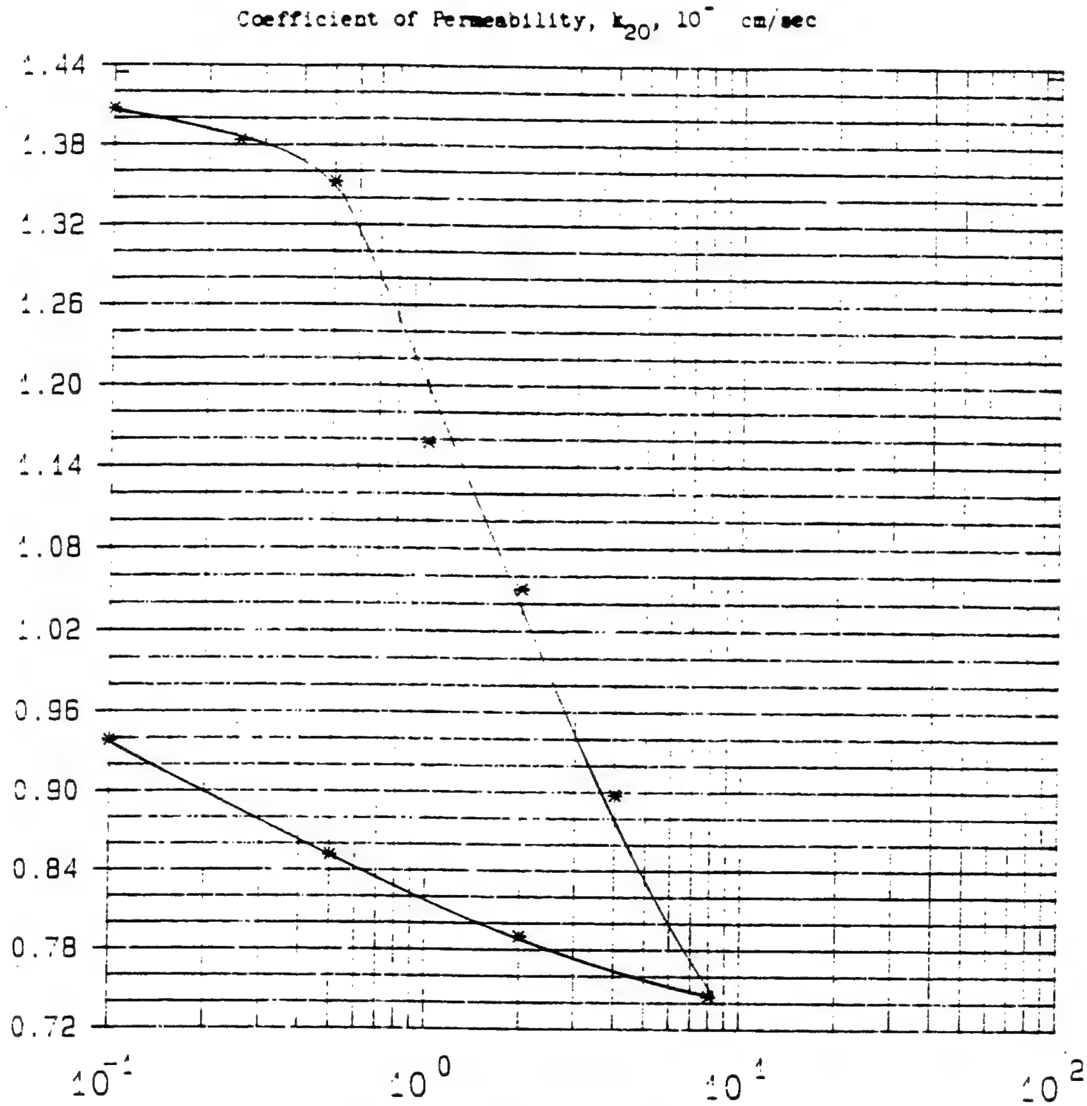
LL = 44	PL = 23	PI = 21	Gs = 2.65	NAT w = %

CLASSIFICATION Sandy clay, CL

GRADATION CURVE

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-106MU
SAMPLE NO.	S-1
DEPTH/ELEV	89'-31'
MRD LAB NO.	90/135

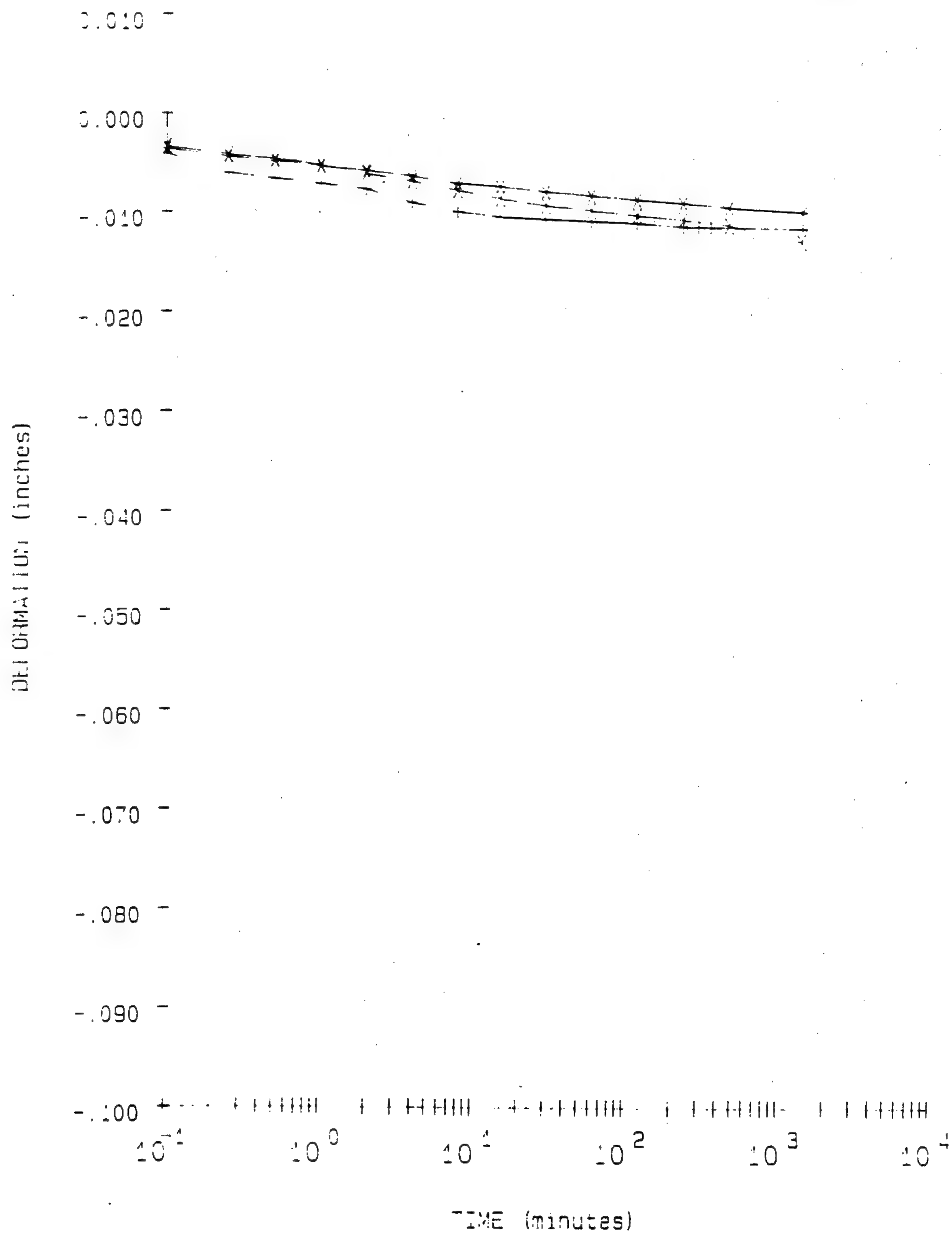
FIGURE 24



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.3 in.	Ht 1 in.	Water Content, w_o	59.1 %	w_f	48.1 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.43	e_f	0.94
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	100 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	62.8 lb/ft³		
Classification Fat clay, CH		k_{20} at e_o = × 10⁻ cm/sec			
LL 96	G_s 2.45	Project	MINNESOTA RIVER: IA-90-04-ED-GH		
PL 37	D_{10}				
Remarks Black		Area	MRD LAB NO. 90/135		
Slightly organic		Boring No. 89-106MU		Sample No. S-2	
No Torvane		Depth El 32'-34'		Date	
Non-calcareous		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 25

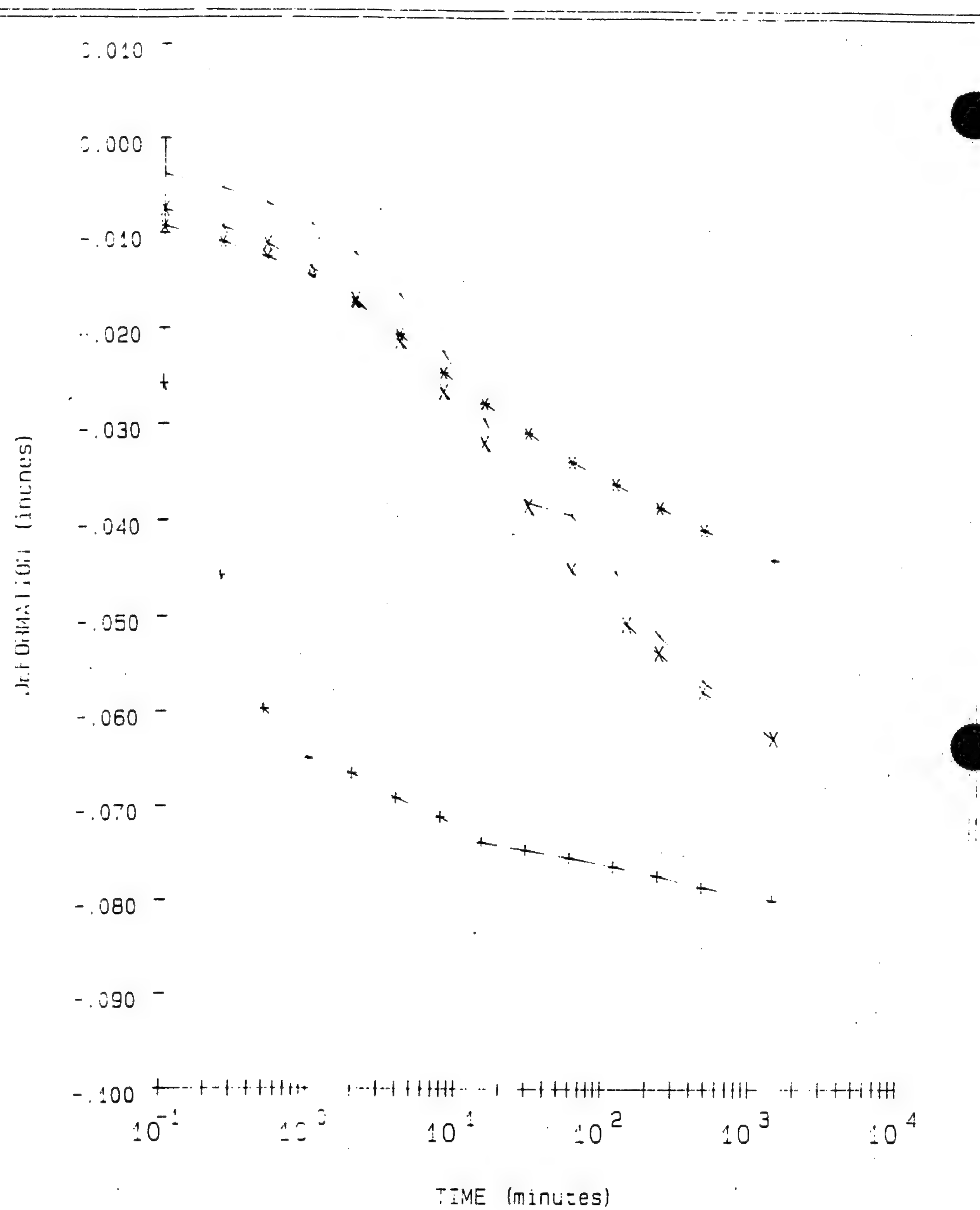


LEGEND

- = .1 TSF
+ = .25 TSF
X = .5 TSF

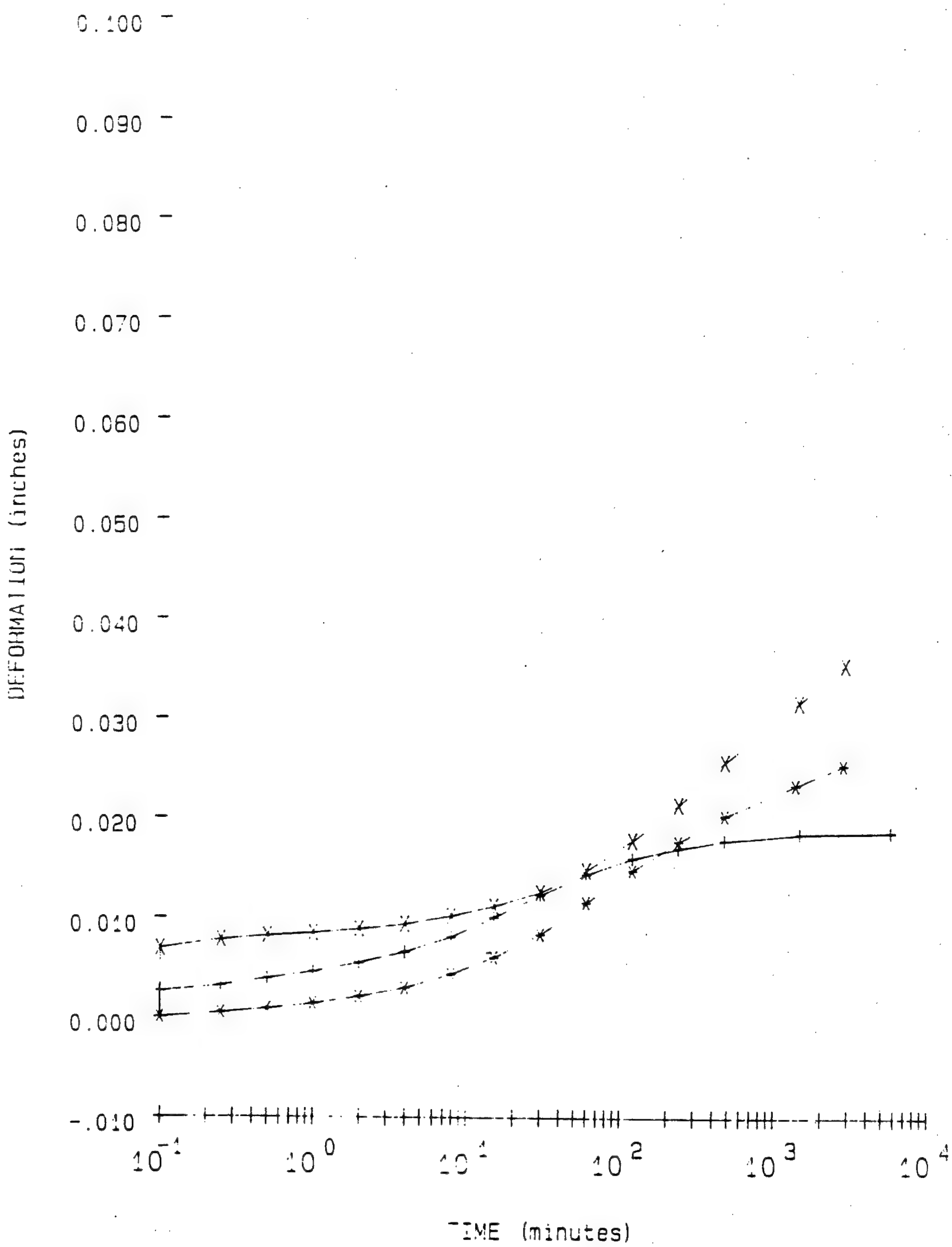
PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-106MU
SAMPLE NO.	S-2
DEPTH/ELEV	32'-34'
MRD LAB NO.	90/135

FIGURE 26



LEGEND		PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
+ = 1	TSF		
* = 2	TSF	BORING NO.	89-106MU
X = 4	TSF	SAMPLE NO.	S-2
- = 8	TSF	DEPTH/ELEV	32'-34'
		MRD LAB NO.	90/135

FIGURE 27



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-106MU
SAMPLE NO.	S-2
DEPTH/ELEV	32'-34'
MRD LAB NO.	90/135

FIGURE 28

Consolidation Test Data

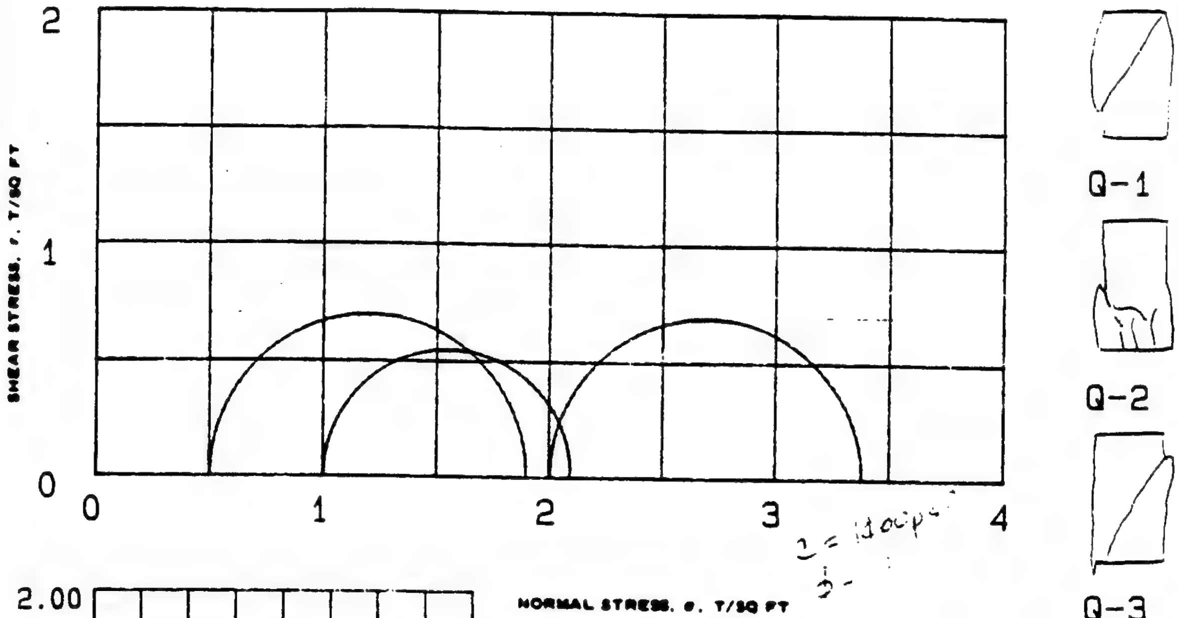
Project MINNESOTA RIVER; IA-90-04-ED-GH

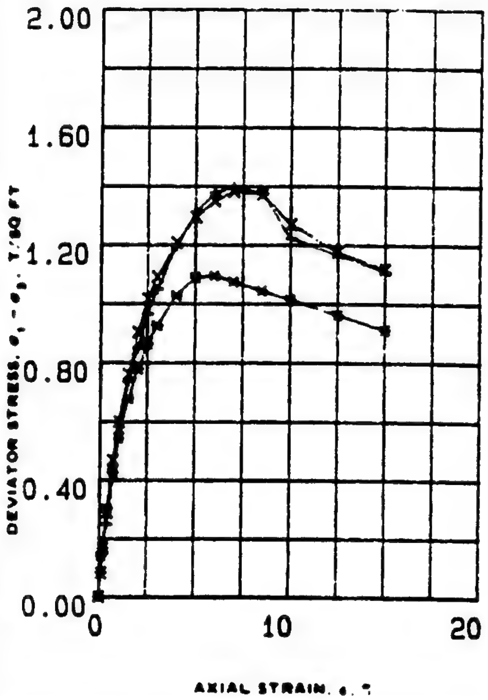
Boring No. 89-106MU
Sample No. S-2
Depth/Elev 32'-34'
MRD Lab No. 90/135

Gs = 2.45
eo = 1.435
0.42eo = 0.603

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
59.1	236.0	62.8	1.435		100.0
48.1	236.0	63.5	1.407	0.10	83.8
48.1	236.0	64.1	1.383	0.25	85.2
48.1	236.0	65.0	1.352	0.50	87.2
48.1	236.0	70.9	1.158	1.00	100.0
48.1	236.0	74.6	1.050	2.00	100.0
48.1	236.0	80.6	0.897	4.00	100.0
'8.1	236.0	87.6	0.744	8.00	100.0
,8.1	236.0	85.4	0.790	2.00	100.0
48.1	236.0	82.6	0.852	0.50	100.0
48.1	236.0	78.9	0.938	0.10	100.0

Axial Strain (%)	Void Ratio
1	1.410
2	1.386
3	1.362
4	1.337
5	1.313
6	1.288
7	1.264
8	1.240
9	1.215
10	1.191
11	1.167
12	1.142
13	1.118
14	1.094
15	1.069
16	1.045
17	1.021
18	0.996
19	0.972
20	0.948





SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	85.6	82.5	82.7	
	DRY DENSITY LB/CU FT	γd_o	48.5	49.6	49.5	
	SATURATION, %	S_o	97.0	97.0	97.0	
	VOID RATIO	e_o	2.16	2.08	2.09	
BEFORE SHEAR	WATER CONTENT, %	w_c	85.4	84.1	82.6	
	DRY DENSITY LB/CU FT	γd_c	48.5	49.6	49.5	
	SATURATION, %	S_c	97.0	99.0	97.0	
	VOID RATIO	e_c	2.16	2.08	2:09	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.40	1.10	1.38	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	15.8	12.8	15.5	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.11	0.91	1.12	
INITIAL DIAMETER, IN.		D_o	1.41	1.41	1.41	
INITIAL HEIGHT, IN.		H_o	2.96	2.95	2.96	

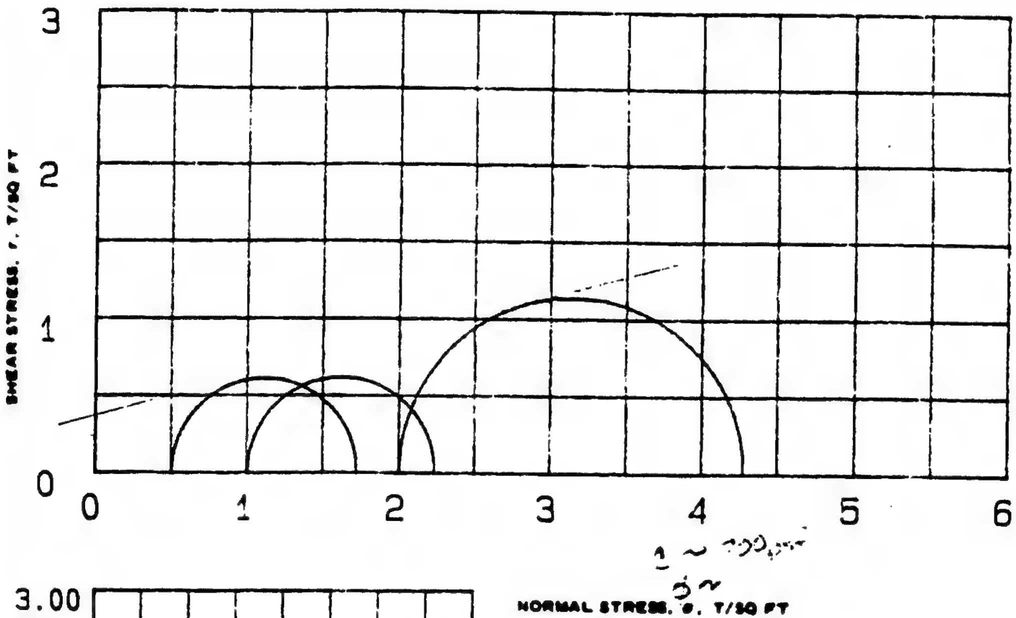
CONTROLLED- STRAIN TEST

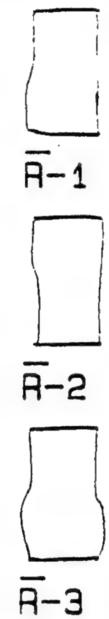
DESCRIPTION OF SPECIMENS Fat clay, CH

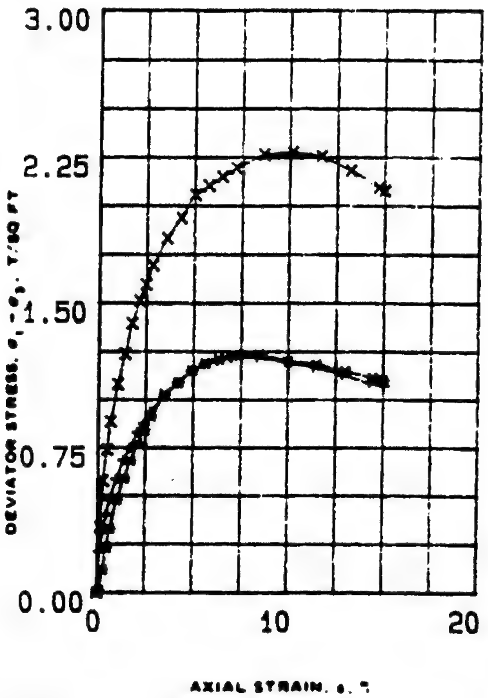
LL 96	PL 37	PI 59	G_s 2.45	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Black	PROJECT MINNESOTA RIVER: TA-90-04-FD-BH
Slightly organic	
No Torvane	BORING NO 89-106 MU — SAMPLE NO. S-2
Non-Calcareous	DEPTH ELEV 32'-34'
	LABORATORY 90/135 — DATE
	TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 29







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	84.1	79.2	81	
	DRY DENSITY LB/CU FT	γ_{d_o}	48.6	51.6	50.1	
	SATURATION, %	S_o	96	99	97	
	VOID RATIO	e_o	2.15	1.96	2.05	
BEFORE SHEAR	WATER CONTENT, %	w_c	86.1	77.1	78.2	
	DRY DENSITY LB/CU FT	γ_{d_c}	49.4	55.1	55.7	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	2.1	1.77	1.75	
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.543	5.543	5.543	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.221	1.235	2.277	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	720	720	840	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.071	1.100	2.078	
INITIAL DIAMETER, IN.		D_o	1.4	1.41	1.4	
INITIAL HEIGHT, IN.		H_o	2.99	3	3	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH B-value 1.0 1.0 1.0

LL 96 | PL 37 | PI 59 | G_s 2.45

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST R̄

REMARKS: Black
Slightly organic
No Torvane
Non-calcareous

PROJECT MINNESOTA RIVER: IA-90-04-FD-6H

BORING NO. 89-106 MU | SAMPLE NO. S-2

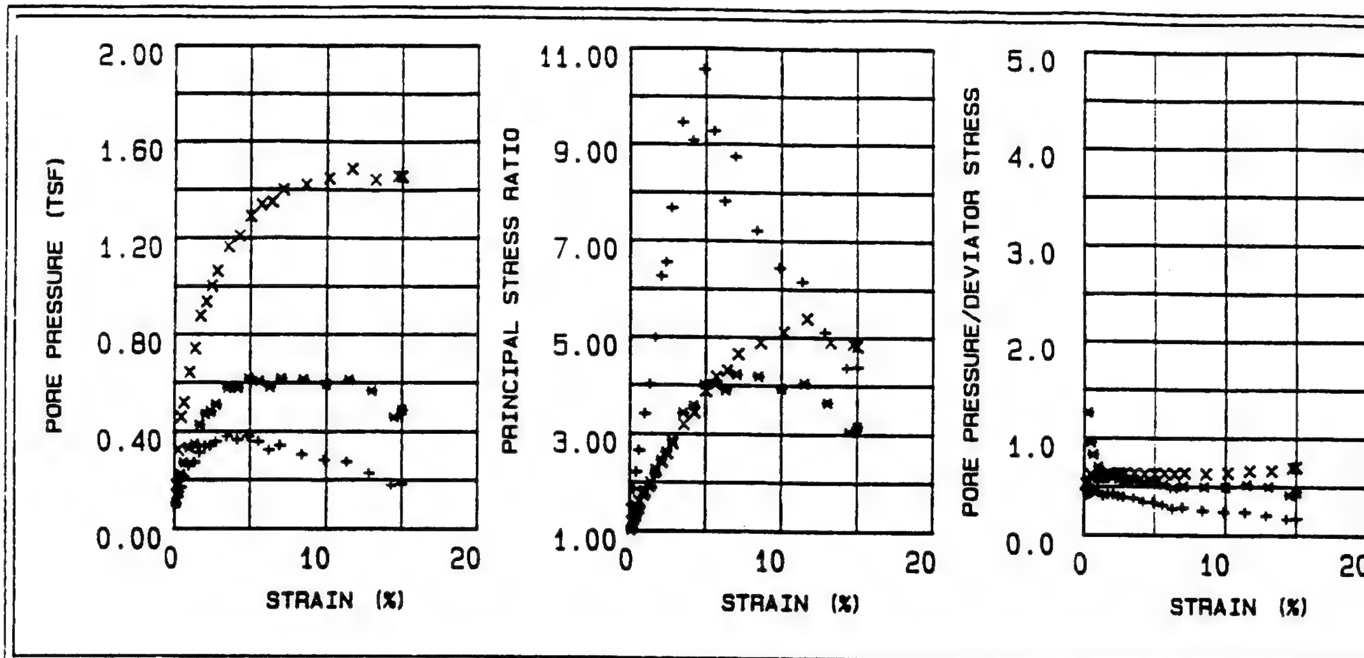
DEPTH ELEV 32'-34'

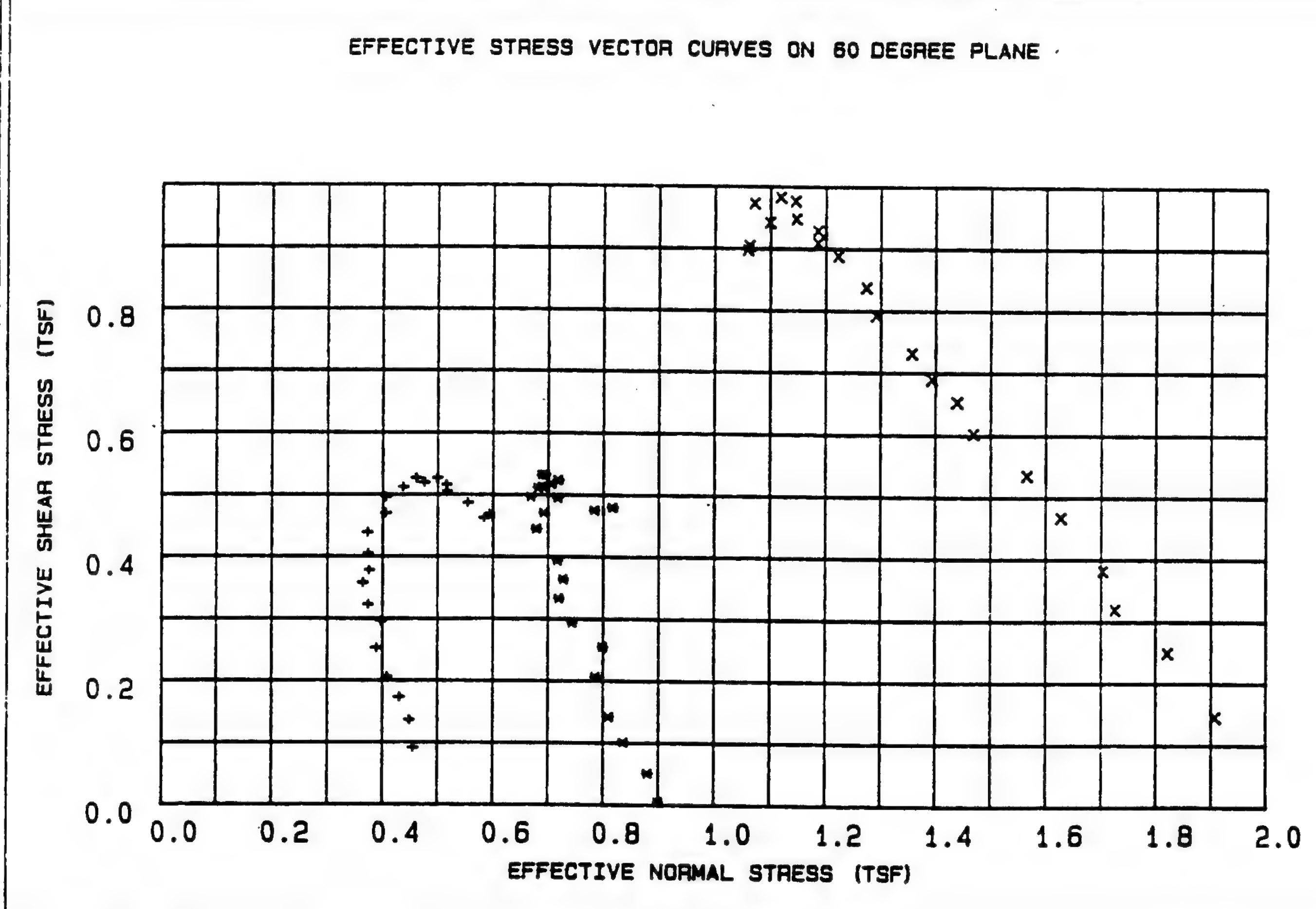
LABORATORY 90/135 | DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 30





LEGEND

+ = .5 TSF

✱ = 1 TSF

X = 2 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-106 MU
SAMPLE NO.	S-2
DEPTH/ELEV	32'-34'
MRD LAB NO.	90/135

FIGURE 31

R

Table 10 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-106 MU
Sample Number : S-2
Depth : 32'-34'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.210	0.097	1.521	0.461	0.455	0.091
30	0.29	0.314	0.130	1.849	0.414	0.448	0.136
45	0.47	0.400	0.169	2.208	0.423	0.430	0.173
60	0.64	0.477	0.211	2.649	0.443	0.407	0.206
90	1.00	0.586	0.257	3.410	0.439	0.388	0.253
120	1.35	0.685	0.273	4.015	0.399	0.397	0.296
150	1.69	0.749	0.312	4.981	0.417	0.373	0.323
180	2.07	0.829	0.342	6.254	0.413	0.363	0.358
210	2.40	0.875	0.342	6.545	0.391	0.375	0.378
240	2.75	0.938	0.359	7.673	0.384	0.373	0.405
300	3.47	1.018	0.380	9.462	0.373	0.372	0.439
360	4.16	1.089	0.365	9.083	0.336	0.405	0.470
420	4.87	1.150	0.380	10.561	0.331	0.405	0.496
4[illegible]	5.56	1.186	0.357	9.267	0.301	0.437	0.512
540	6.25	1.204	0.323	7.815	0.269	0.475	0.520
600	6.96	1.221	0.342	8.734	0.281	0.460	0.527
720	8.38	1.221	0.303	7.204	0.249	0.499	0.527
840	9.86	1.196	0.280	6.436	0.235	0.516	0.516
960	11.33	1.170	0.273	6.151	0.234	0.517	0.505
1080	12.83	1.128	0.225	5.105	0.200	0.554	0.487
1200	14.28	1.088	0.176	4.358	0.162	0.593	0.469
1261	15.00	1.071	0.183	4.379	0.171	0.583	0.462

Table - Triaxial $\bar{R}$ Test Results

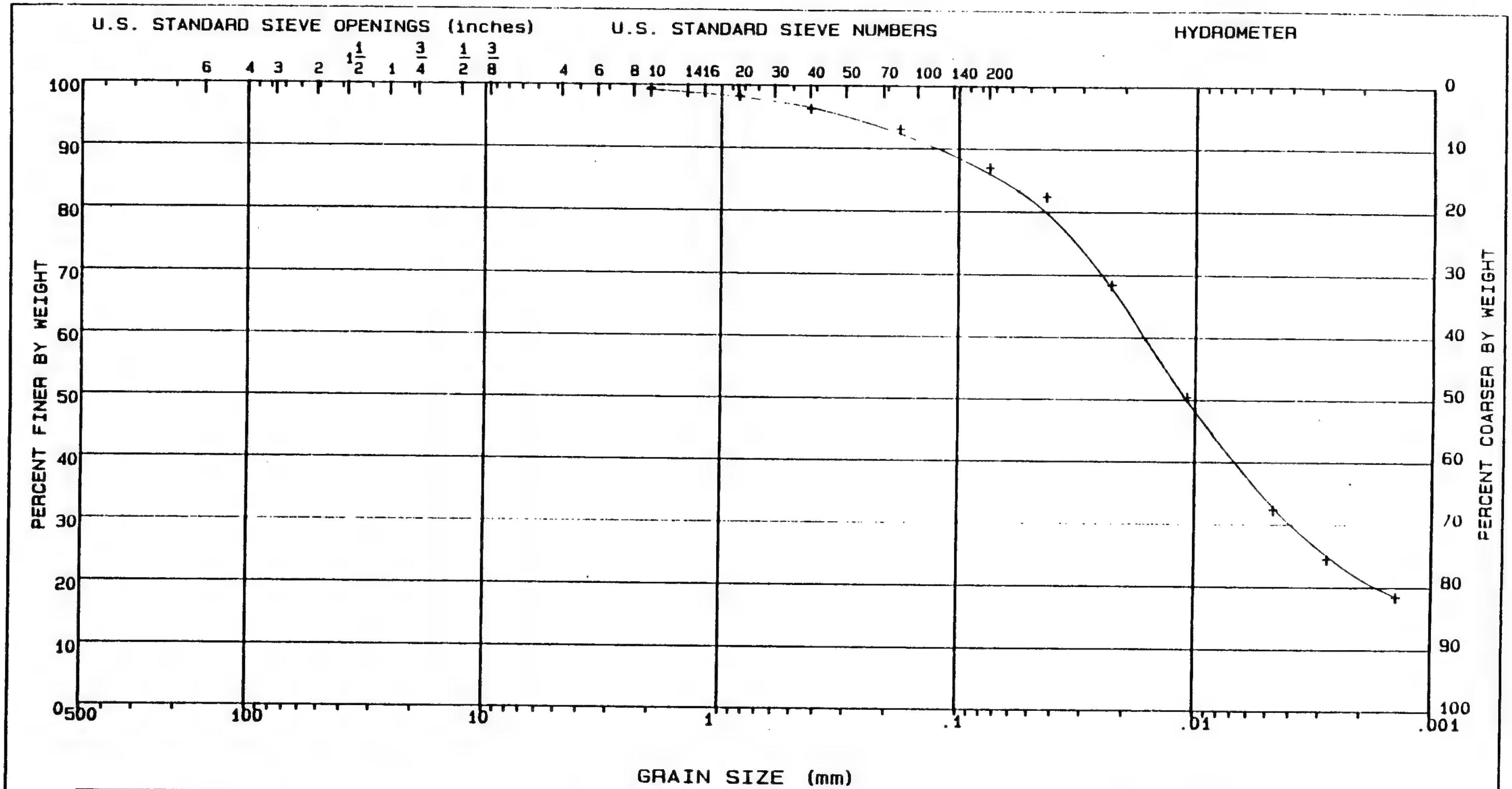
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-106 MU
Sample Number : S-2
Depth : 32'-34'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.011	0.104	1.013	9.054	0.899	0.005
30	0.29	0.118	0.149	1.139	1.261	0.880	0.051
45	0.48	0.234	0.222	1.300	0.952	0.836	0.101
60	0.65	0.329	0.271	1.452	0.825	0.810	0.142
90	1.01	0.480	0.333	1.720	0.695	0.786	0.207
120	1.37	0.591	0.347	1.906	0.588	0.799	0.255
150	1.71	0.682	0.426	2.189	0.625	0.743	0.294
180	2.09	0.772	0.472	2.463	0.612	0.719	0.333
210	2.43	0.843	0.482	2.628	0.573	0.727	0.364
240	2.79	0.913	0.510	2.864	0.560	0.716	0.394
300	3.52	1.031	0.577	3.435	0.559	0.678	0.445
360	4.21	1.092	0.578	3.588	0.530	0.692	0.471
420	4.94	1.152	0.617	4.010	0.536	0.668	0.497
480	5.63	1.192	0.606	4.026	0.509	0.689	0.514
[illegible]	6.33	1.213	0.582	3.903	0.480	0.718	0.524
6[illegible]0	7.05	1.233	0.617	4.222	0.501	0.688	0.532
720	8.50	1.235	0.612	4.182	0.496	0.694	0.533
840	9.99	1.200	0.591	3.932	0.492	0.706	0.518
960	11.48	1.183	0.612	4.046	0.518	0.681	0.511
1080	13.00	1.147	0.567	3.647	0.495	0.717	0.495
1200	14.47	1.113	0.458	3.054	0.412	0.817	0.480
1245	15.00	1.100	0.488	3.159	0.444	0.784	0.475

Table 12 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-106 MU
Sample Number : S-2
Depth : 32'-34'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.336	0.176	1.184	0.523	1.907	0.145
30	0.29	0.576	0.322	1.343	0.559	1.821	0.249
45	0.49	0.740	0.458	1.480	0.620	1.725	0.319
60	0.66	0.885	0.517	1.597	0.585	1.702	0.382
90	1.03	1.081	0.641	1.796	0.594	1.627	0.467
120	1.39	1.239	0.741	1.984	0.599	1.566	0.535
150	1.74	1.396	0.877	2.243	0.629	1.469	0.602
180	2.13	1.514	0.936	2.423	0.619	1.439	0.653
210	2.47	1.596	1.002	2.599	0.628	1.393	0.689
240	2.84	1.694	1.062	2.807	0.627	1.357	0.731
300	3.57	1.835	1.162	3.190	0.633	1.292	0.792
360	4.28	1.939	1.206	3.443	0.622	1.274	0.837
420	5.01	2.058	1.288	3.890	0.626	1.222	0.88[illegible]
480	5.72	2.105	1.336	4.170	0.635	1.185	0.90[illegible]
[illegible]	6.43	2.152	1.348	4.301	0.627	1.185	0.929
[illegible]	7.16	2.196	1.398	4.648	0.637	1.146	0.948
720	8.63	2.265	1.417	4.888	0.626	1.144	0.977
840	10.15	2.277	1.446	5.110	0.636	1.118	0.983
960	11.66	2.255	1.487	5.393	0.660	1.071	0.973
1080	13.21	2.182	1.441	4.900	0.661	1.099	0.942
1200	14.70	2.095	1.457	4.856	0.696	1.062	0.904
1225	15.00	2.078	1.455	4.816	0.701	1.059	0.897



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

LL = 96	PL = 37	PI = 59	Gs = 2.45	NAT w = %

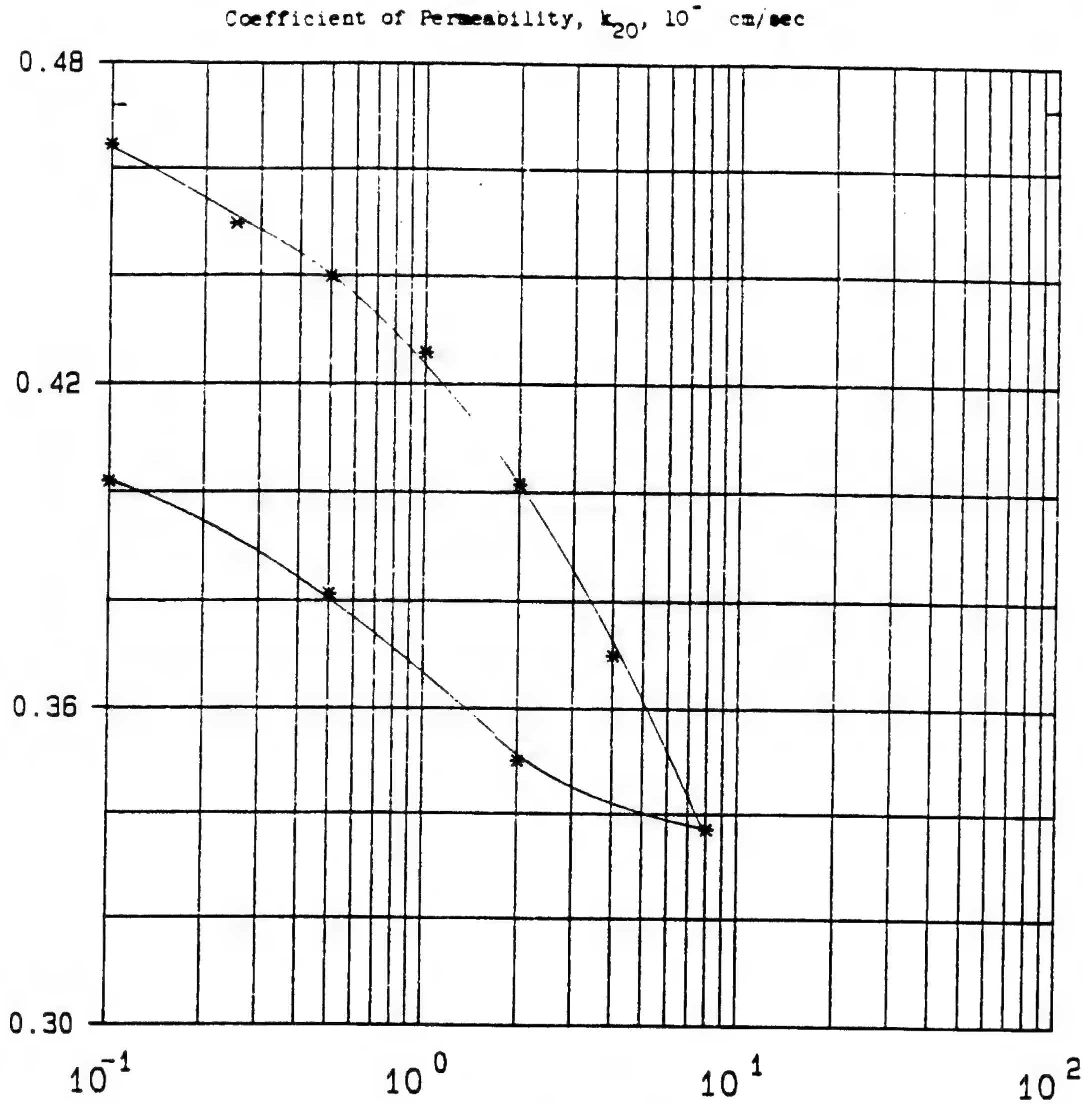
CLASSIFICATION Fat clay, CH

GRADATION CURVE

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-106 MU
SAMPLE NO.	S-2
DEPTH/ELEV	32'-34'
MRD LAB NO.	90/135

FIGURE 32

due to lack of material ...

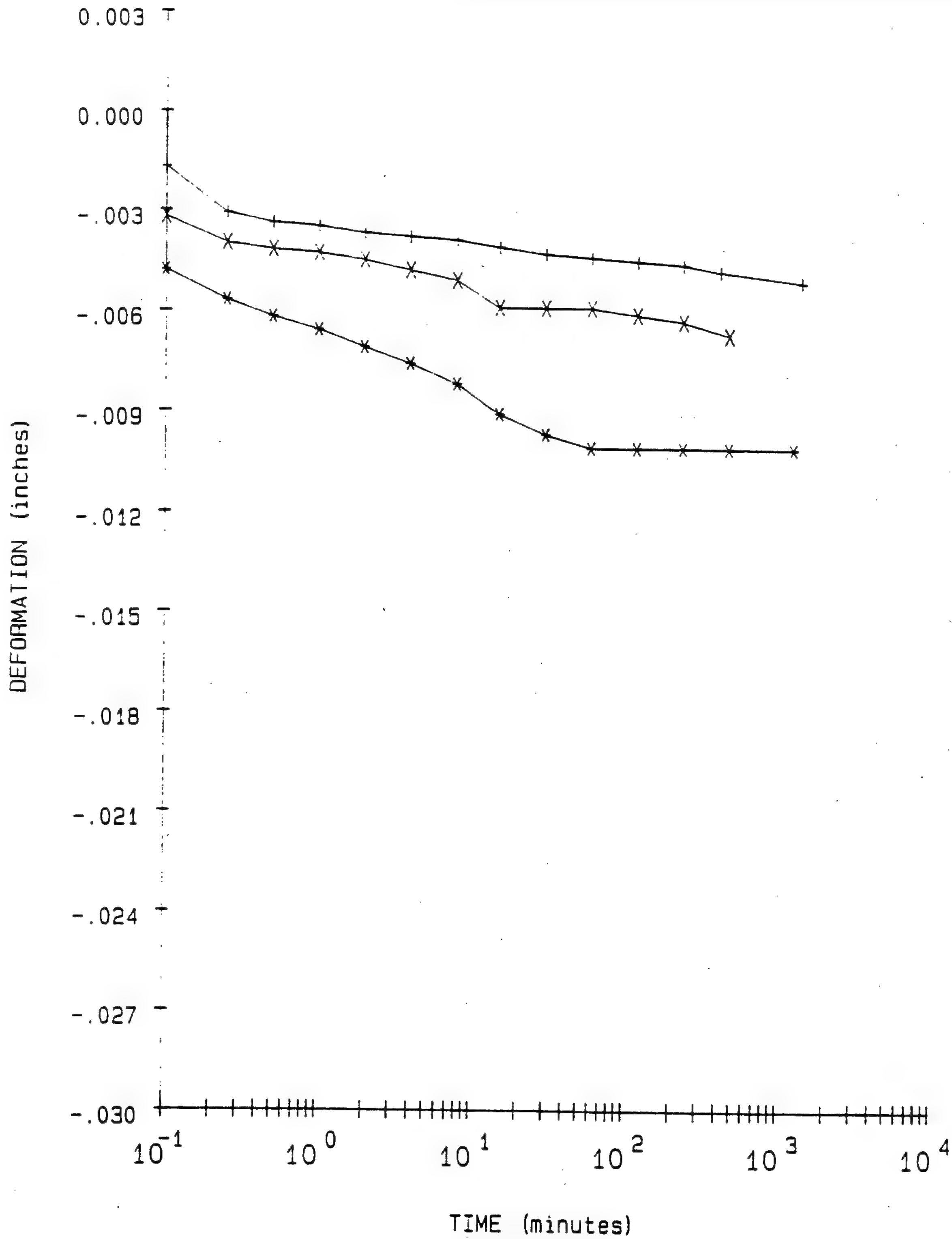


Type of Specimen	UNDISTURBED		Before Test		After Test	
Diam 4.3 in.	Ht 1 in.		Water Content, w_o	16.3 %	w_f	15.3 %
Overburden Pressure, p_o	T/sq ft		Void Ratio, e_o	0.47	e_f	0.40
Preconsol. Pressure, p_c	T/sq ft		Saturation, S_o	91 %	S_f	100 %
Compression Index, C_c			Dry Density, γ_d	112.3 lb/ft^3		
Classification	Clayey gravelly sand, SC		k_{20} at e_o =	x 10^{-} cm/sec		
LL 22	G_s 2.65		Project	MINNESOTA RIVER; IA-90-04-ED-GH		
PL 15	D_{10}					
Remarks	Brown		Area	MRD LAB NO. 90/135		
	No Torvane		Boring No.	89-110 MU	Sample No.	S-3
	Slightly Calcareous		Depth El	21'-23'	Date	

CONSOLIDATION TEST REPORT

ENG FORM 2090 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE.

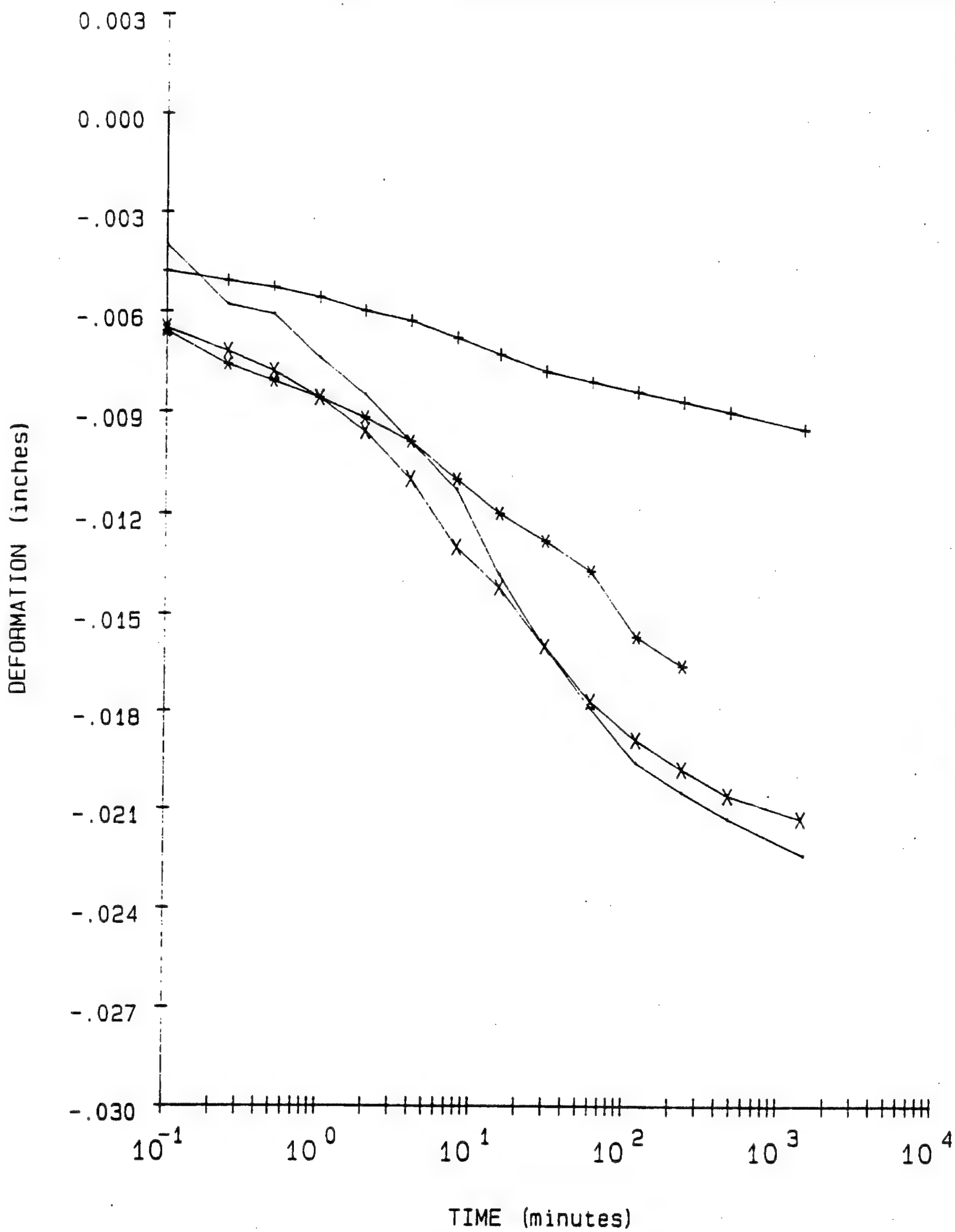
Figure 9



LEGEND	
+ =	.1 TSF
* =	.25 TSF
X =	.5 TSF

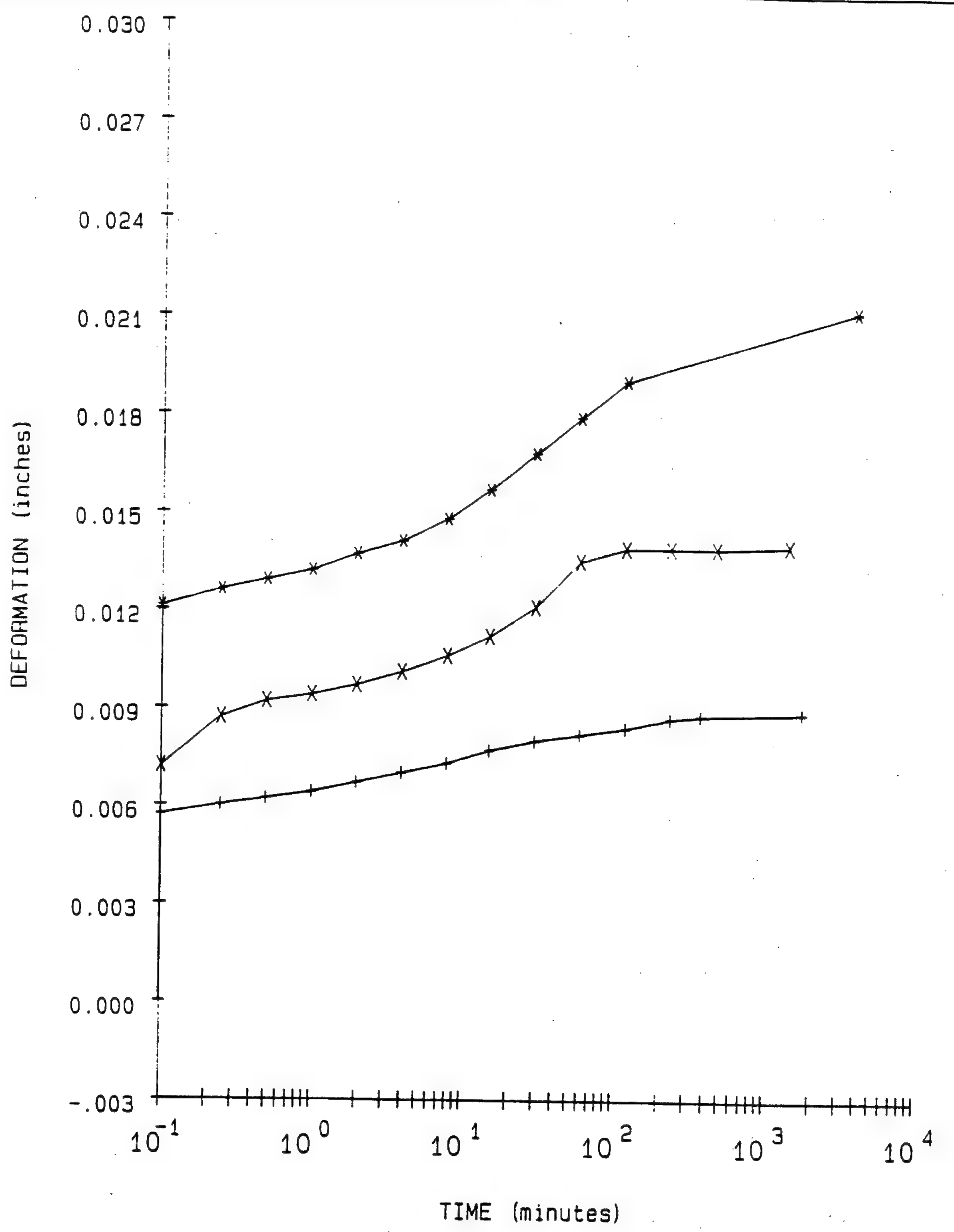
PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-110 MU
SAMPLE NO.	S-3
DEPTH/ELEV	21'-23'
MRD LAB NO.	90/135

FIGURE 10



LEGEND	PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
+ = 1 TSF		
* = 2 TSF	BORING NO.	89-110 MU
X = 4 TSF	SAMPLE NO.	S-3
- = 8 TSF	DEPTH/ELEV	21'-23'
	MRD LAB NO.	90/135

FIGURE 11



LEGEND			
+ =	2	TSF	Rebound
* =	.5	TSF	Rebound
X =	.1	TSF	Rebound

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-110 MU
SAMPLE NO.	S-3
DEPTH/ELEV	21'-23'
MRD LAB NO.	90/135

FIGURE 12

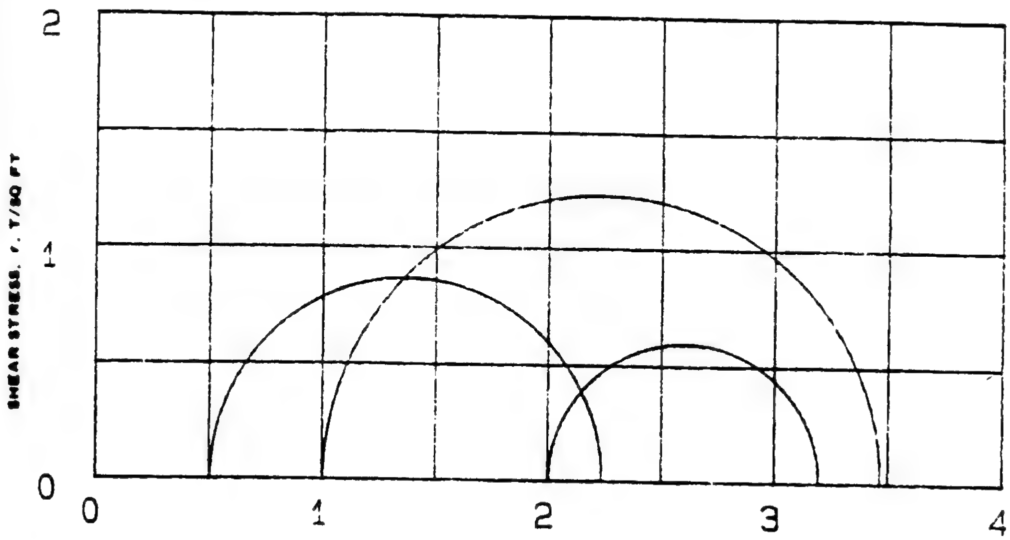
Consolidation Test Data

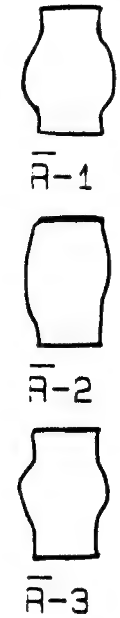
Project	MINNESOTA RIVER; IA-90-04-ED-GH
Boring No.	89-110 MU
Sample No.	S-3
Depth/Elev	21'-23'
MRD Lab No.	90/135

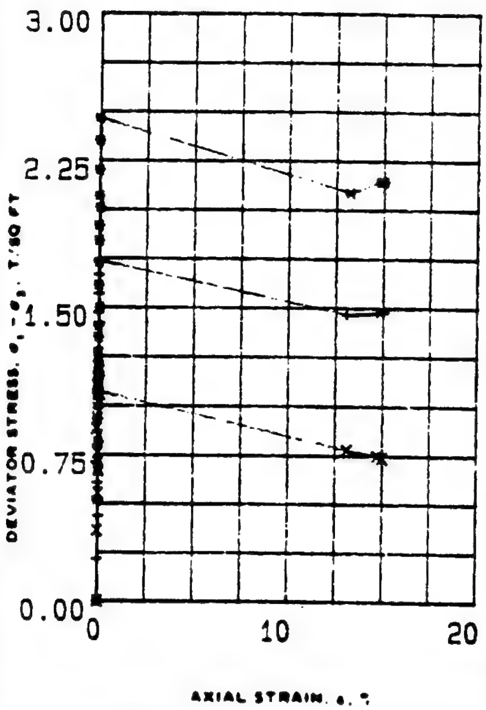
Gs = 2.65
eo = 0.472
0.42eo = 0.198

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
16.3	425.5	112.3	0.472		91.2
15.3	425.5	112.9	0.464	0.10	87.3
15.3	425.5	114.1	0.450	0.25	90.2
15.3	425.5	114.9	0.440	0.50	92.2
15.3	425.5	116.0	0.426	1.00	95.2
15.3	425.5	118.0	0.401	2.00	100.0
15.3	425.5	120.7	0.370	4.00	100.0
15.3	425.5	123.7	0.337	8.00	100.0
15.3	425.5	122.5	0.350	2.00	100.0
15.3	425.5	119.7	0.381	0.50	100.0
15.3	425.5	118.0	0.402	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.457
2	0.442
3	0.428
4	0.413
5	0.398
6	0.384
7	0.369
8	0.354
9	0.339
10	0.325
11	0.310
12	0.295







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	15.5	14.8	15.2	
	DRY DENSITY LB/CU FT	γd_o	113.5	113.5	113.2	
	SATURATION, %	S_o	89	86	87	
	VOID RATIO	e_o	.46	.46	.46	
BEFORE SHEAR	WATER CONTENT, %	w_c	16.8	15.4	17.2	
	DRY DENSITY LB/CU FT	γd_c	114.4	117.6	115.6	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.45	.41	.43	
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.543	5.543	5.543	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.736	2.465	1.193	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	960	960	360	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.477	2.145	0.736	
INITIAL DIAMETER, IN		D_o	1.42	1.42	1.41	
INITIAL HEIGHT, IN		H_o	3	3	3.01	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Clayey gravelly sand, SC B-value 1.0 1.0 1.0

LL 22	PL 15	PI 7	G_s 2.65	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Brown
No Torvane
Slightly Calcareous

PROJECT MINNESOTA RIVER; IS-90-04-ED-GH

BORING NO. 89-110 MU SAMPLE NO. S-3

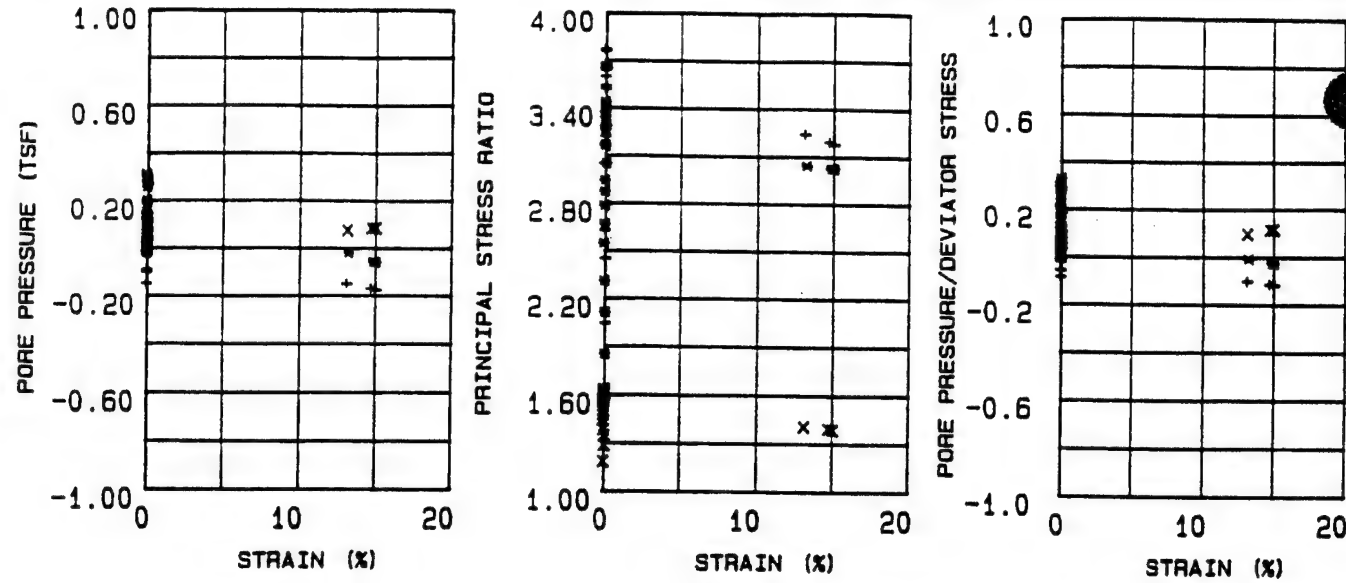
DEPTH ELEV 21'-23'

LABORATORY 90/135 DATE

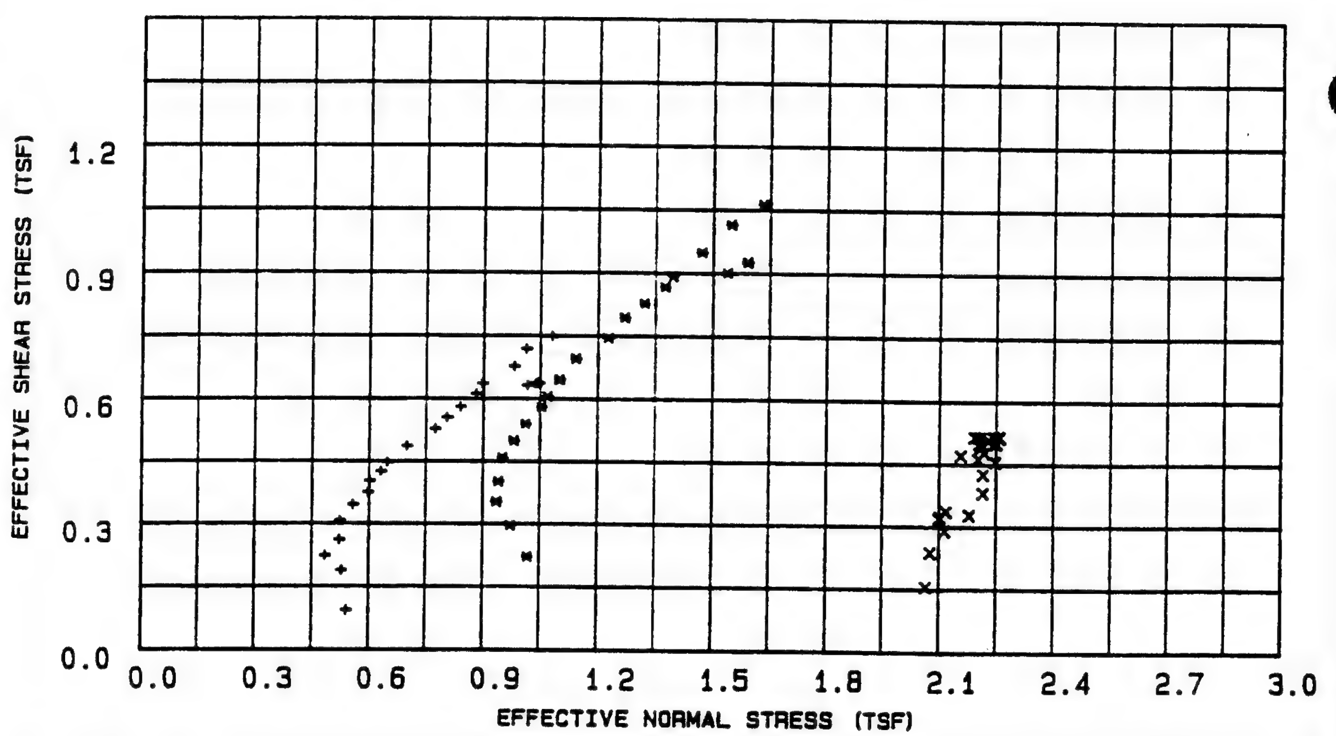
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 13



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF
* = 1 TSF
X = 2 TSF

PROJECT	MINNESOTA RIVER: IS-90-04-ED-GH
BORING NO.	89-110 MU
SAMPLE NO.	S-3
DEPTH/ELEV	21'-23'
MRD LAB NO.	90/135

FIGURE 14

Table 5 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IS-90-04-ED-GH
Boring Number : 89-110 MU
Sample Number : S-3
Depth : 21'-23'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	-0.05	0.216	0.013	1.444	0.060	0.541	0.093
30	0.00	0.436	0.081	2.042	0.186	0.527	0.188
45	0.00	0.516	0.144	2.449	0.279	0.484	0.223
60	-0.05	0.605	0.128	2.626	0.212	0.522	0.261
90	-0.10	0.712	0.152	3.047	0.215	0.524	0.307
120	-0.05	0.799	0.140	3.218	0.175	0.558	0.345
150	-0.05	0.870	0.118	3.279	0.136	0.597	0.375
180	-0.05	0.932	0.130	3.518	0.140	0.601	0.402
210	-0.05	0.985	0.112	3.537	0.114	0.632	0.425
240	0.02	1.036	0.109	3.648	0.105	0.648	0.447
[illegible]	-0.05	1.126	0.080	3.681	0.071	0.699	0.486
[illegible]	-0.05	1.223	0.029	3.596	0.024	0.774	0.528
420	-0.05	1.285	0.013	3.638	0.010	0.805	0.555
480	-0.05	1.347	-0.007	3.654	-0.005	0.840	0.581
540	0.00	1.416	-0.030	3.673	-0.021	0.881	0.611
600	-0.05	1.471	-0.033	3.759	-0.022	0.897	0.635
720	-0.05	1.568	-0.092	3.650	-0.058	0.980	0.677
840	-0.05	1.665	-0.101	3.769	-0.060	1.013	0.719
960	-0.05	1.736	-0.151	3.665	-0.087	1.081	0.749
1080	13.09	1.463	-0.153	3.239	-0.104	1.015	0.631
1200	14.69	1.473	-0.173	3.191	-0.117	1.038	0.636
1223	15.00	1.477	-0.179	3.176	-0.121	1.045	0.637

Table 4 - Triaxial $\bar{R}$ Test Results

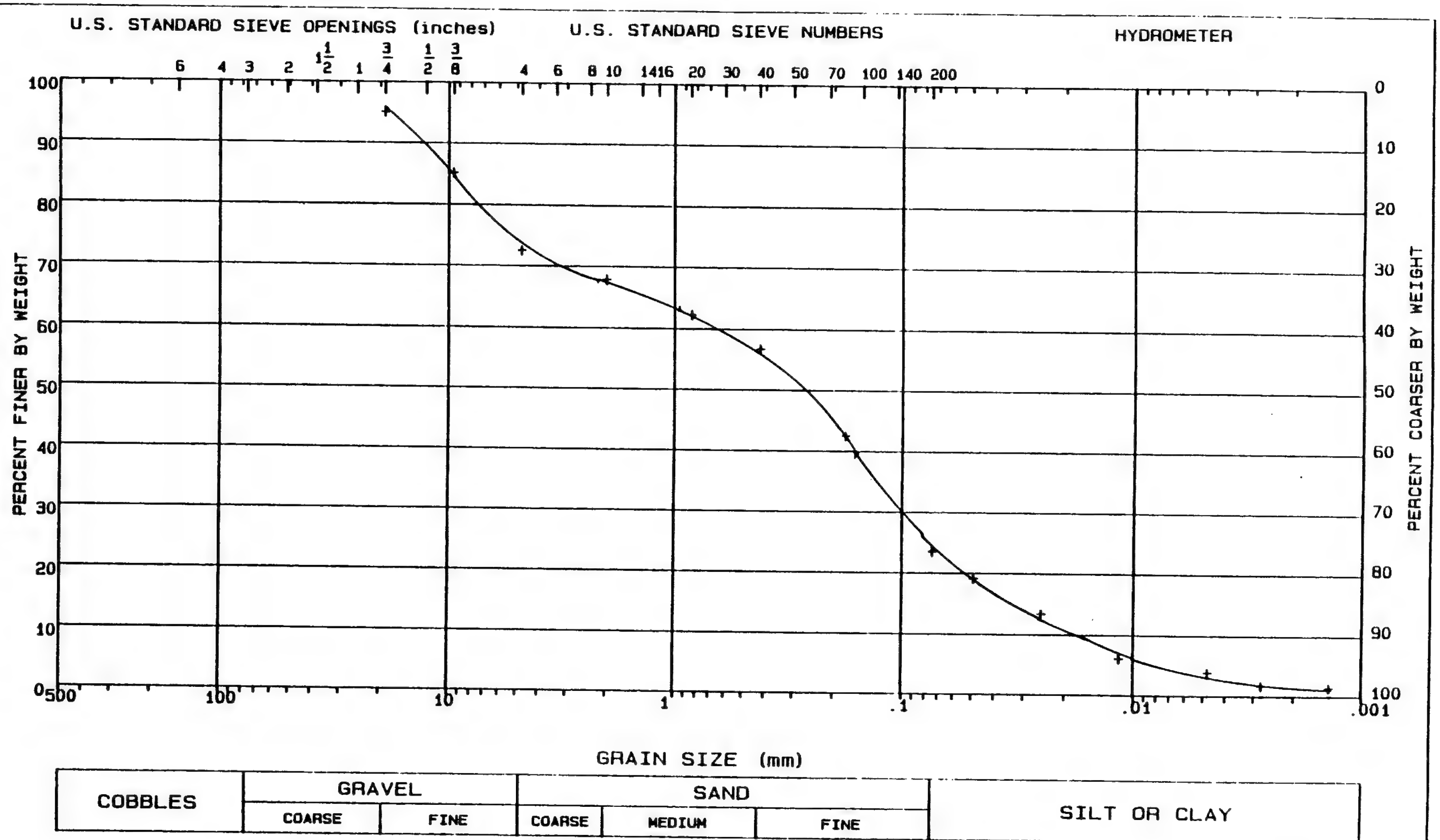
Project : MINNESOTA RIVER; IS-90-04-ED-GH
Boring Number : 89-110 MU
Sample Number : S-3
Depth : 21'-23'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	-0.05	0.513	0.109	1.576	0.214	1.018	0.221
30	0.00	0.683	0.197	1.850	0.290	0.972	0.295
45	0.00	0.815	0.266	2.111	0.327	0.936	0.352
60	-0.05	0.930	0.289	2.308	0.311	0.941	0.401
90	-0.10	1.063	0.312	2.546	0.294	0.951	0.459
120	-0.05	1.157	0.305	2.665	0.264	0.981	0.499
150	-0.05	1.252	0.298	2.783	0.238	1.012	0.540
180	-0.05	1.347	0.280	2.871	0.209	1.053	0.581
210	-0.05	1.404	0.277	2.941	0.198	1.070	0.606
240	0.02	1.497	0.270	3.049	0.181	1.101	0.646
300	-0.05	1.612	0.256	3.166	0.159	1.143	0.696
360	-0.05	1.726	0.201	3.160	0.117	1.226	0.745
420	-0.05	1.839	0.187	3.262	0.102	1.268	0.79[illegible]
480	-0.05	1.915	0.153	3.262	0.081	1.321	0.82[illegible]
5[illegible]	0.00	2.009	0.122	3.287	0.061	1.375	0.867
6[illegible]	-0.05	2.067	0.116	3.339	0.057	1.396	0.892
720	-0.05	2.200	0.074	3.375	0.034	1.471	0.949
840	-0.05	2.351	0.035	3.437	0.015	1.547	1.015
960	-0.05	2.465	-0.021	3.414	-0.008	1.631	1.064
1080	13.21	2.086	-0.021	3.043	-0.010	1.537	0.900
1200	14.83	2.144	-0.058	3.026	-0.027	1.589	0.925
1212	15.00	2.145	-0.060	3.023	-0.028	1.591	0.926

Table 6 - Triaxial $\bar{R}$ Test Results

Project	: MINNESOTA RIVER; IS-90-04-ED-GH
Boring Number	: 89-110 MU
Sample Number	: S-3
Depth	: 21'-23'
Confining Pressure	: 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	-0.05	0.359	0.024	1.182	0.068	2.065	0.155
30	0.00	0.549	0.059	1.283	0.107	2.077	0.237
45	0.00	0.671	0.051	1.344	0.077	2.115	0.289
60	-0.05	0.758	0.008	1.381	0.010	2.180	0.327
90	-0.10	0.881	0.003	1.441	0.004	2.215	0.380
120	-0.05	0.984	0.029	1.499	0.030	2.215	0.425
150	-0.05	1.054	0.014	1.530	0.013	2.247	0.455
180	-0.05	1.106	0.056	1.569	0.051	2.218	0.477
210	-0.05	1.140	0.072	1.592	0.064	2.210	0.492
240	0.02	1.174	0.062	1.606	0.053	2.229	0.507
300	-0.05	1.158	0.038	1.590	0.033	2.249	0.500
360	-0.05	1.193	0.053	1.612	0.045	2.242	0.515
420	-0.05	1.193	0.038	1.608	0.032	2.257	0.515
480	-0.05	1.193	0.102	1.629	0.086	2.193	0.515
[illegible]	0.00	1.192	0.089	1.624	0.075	2.206	0.514
[illegible]	-0.05	1.193	0.102	1.629	0.086	2.193	0.515
720	-0.05	1.158	0.081	1.603	0.071	2.206	0.500
840	-0.05	1.088	0.113	1.577	0.104	2.156	0.470
960	-0.05	1.071	0.063	1.553	0.060	2.202	0.462
1080	13.12	0.777	0.074	1.404	0.095	2.118	0.335
1200	14.72	0.746	0.084	1.390	0.113	2.101	0.322
1221	15.00	0.736	0.084	1.384	0.115	2.098	0.318



LL = 22 | PL = 15 | PI = 7 | Gs = 2.65 | NAT w = %

CLASSIFICATION Clayey gravelly sand, SC

GRADATION CURVE

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

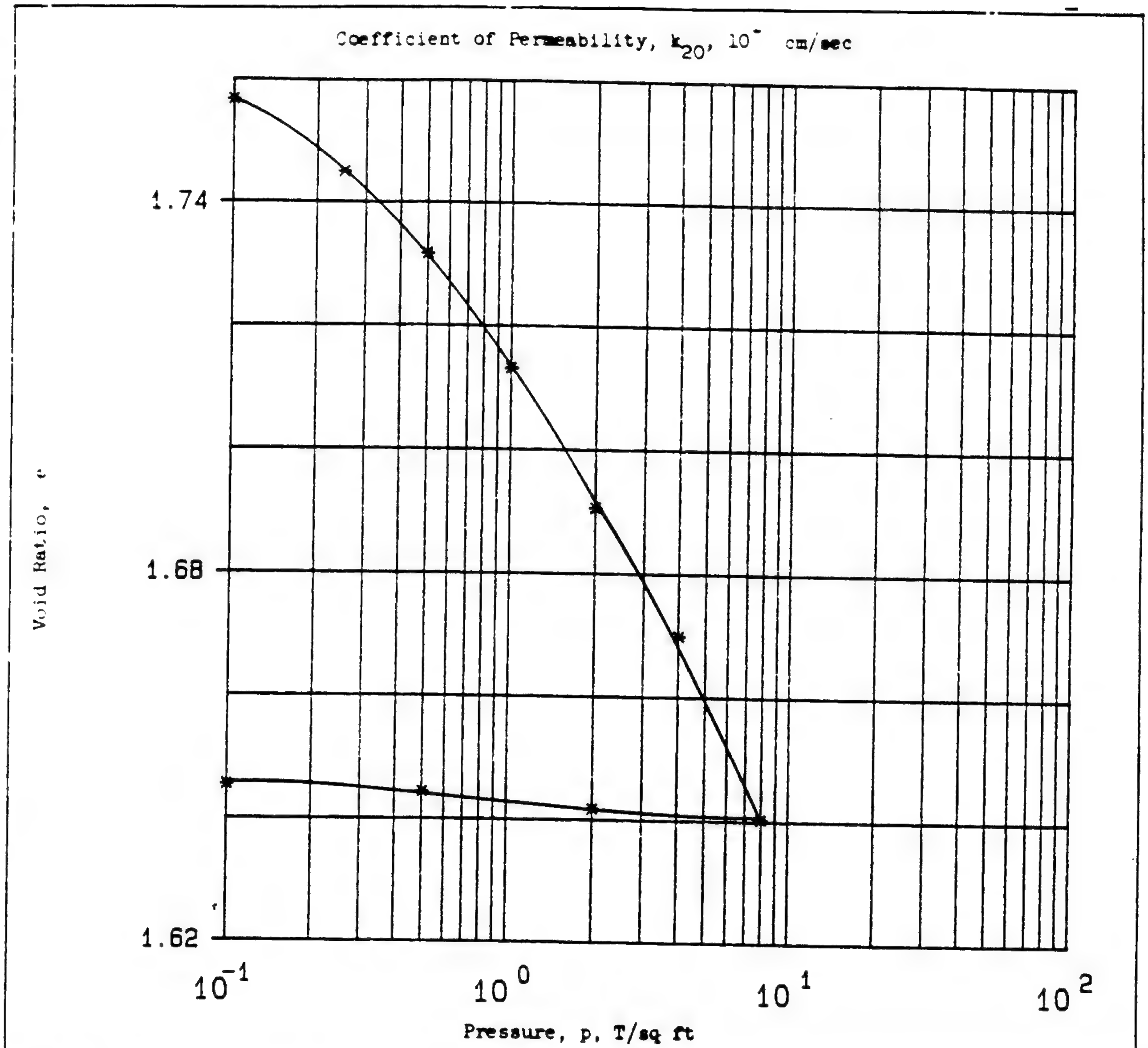
BORING NO. 89-110 MU

SAMPLE NO. S-3

DEPTH/ELEV 21'-23'

MRD LAB NO. 90/135

FIGURE 15

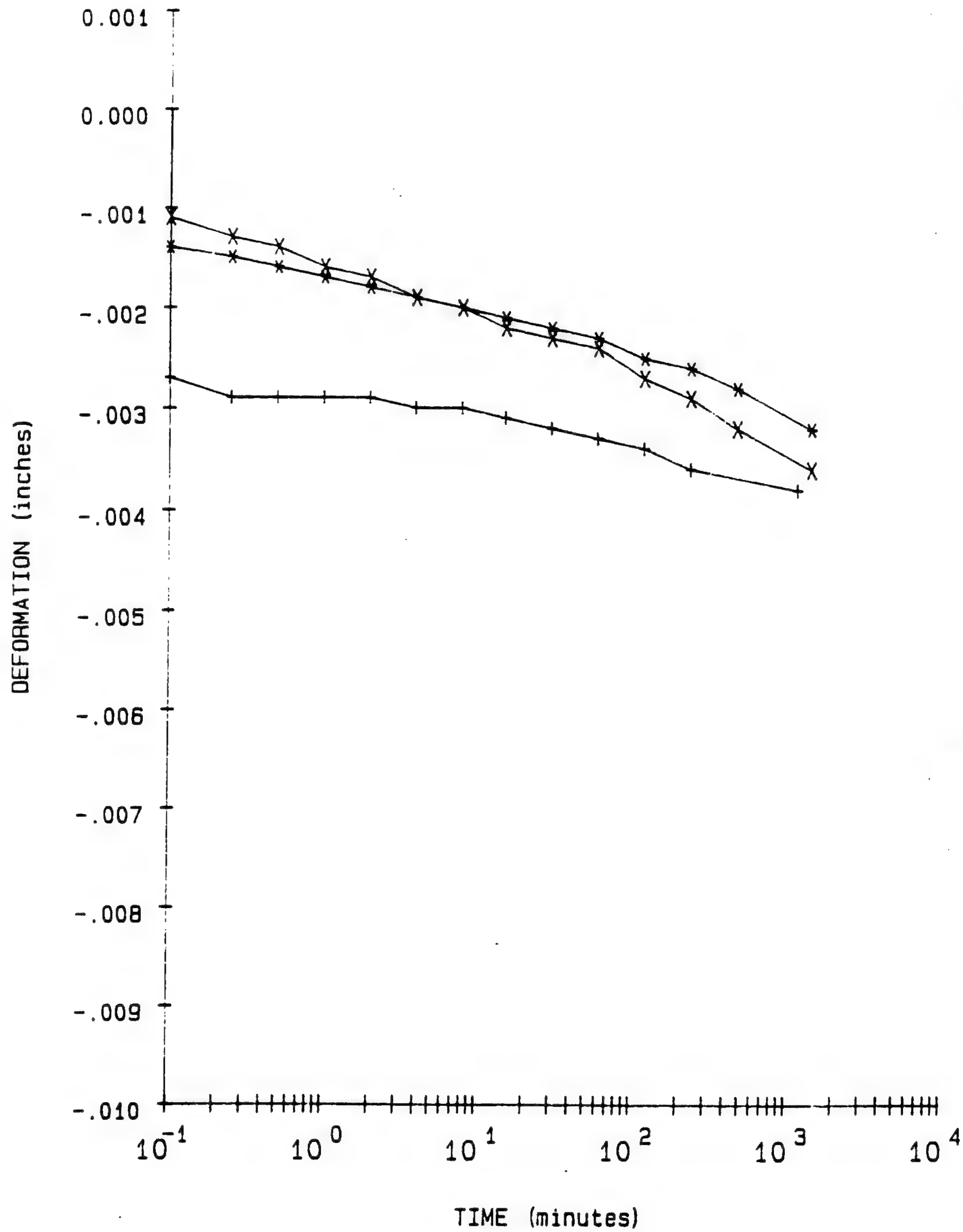


Type of Specimen	UNDISTURBED			Before Test		After Test	
Diam	2.5 in.	Ht	.75 in.	Water Content, w_o	29.6 %	w_f	23.7 %
Overburden Pressure, p_o			T/sq ft	Void Ratio, e_o	1.77	e_f	1.65
Preconsol. Pressure, p_c			T/sq ft	Saturation, S_o	45 %	S_f	39 %
Compression Index, C_c				Dry Density, γ_d	60.3 lb/ft^3		
Classification	Sandy clay, CL			k_{20} at e_o =	$\times 10^{-}$ cm/sec		
LL 38		G_s	2.68	Project	MINNESOTA RIVER: IA-90-04-FD-GH		
PL 19		D_{10}					
Remarks	Brown			Area	MRD LAB NO. 90/135		
	Torvane=0.26 TSF			Boring No.	89-110 MU	Sample No.	S-4
	Non-calcareous			Depth El	31'-33'	Date	

CONSOLIDATION TEST REPORT

ENG FORM 2090 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE.

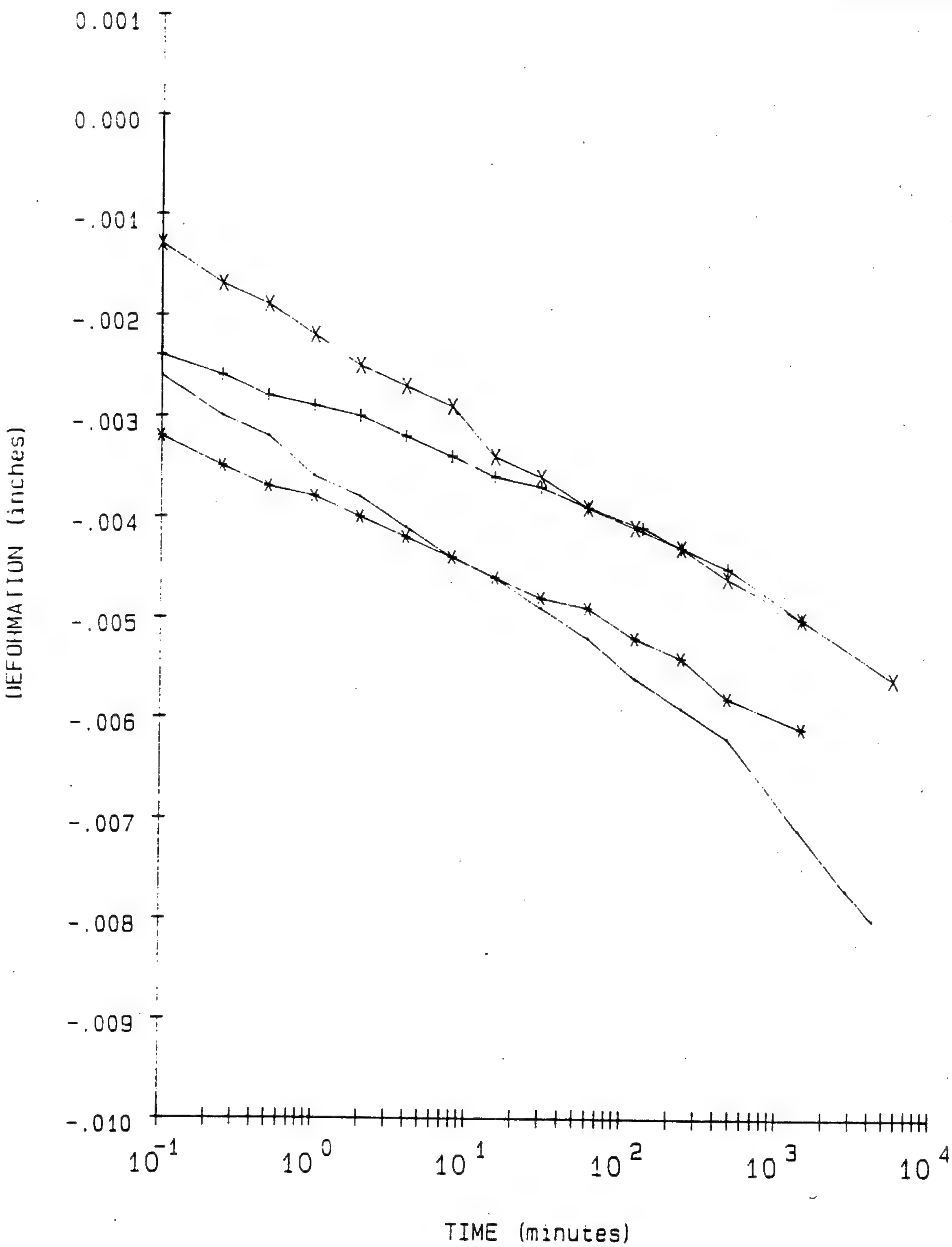
Figure 33



LEGEND	
+ = .1 TSF	
* = .25 TSF	
X = .5 TSF	

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-110 MU
SAMPLE NO.	S-4
DEPTH/ELEV	31'-33'
MRD LAB NO.	90/135

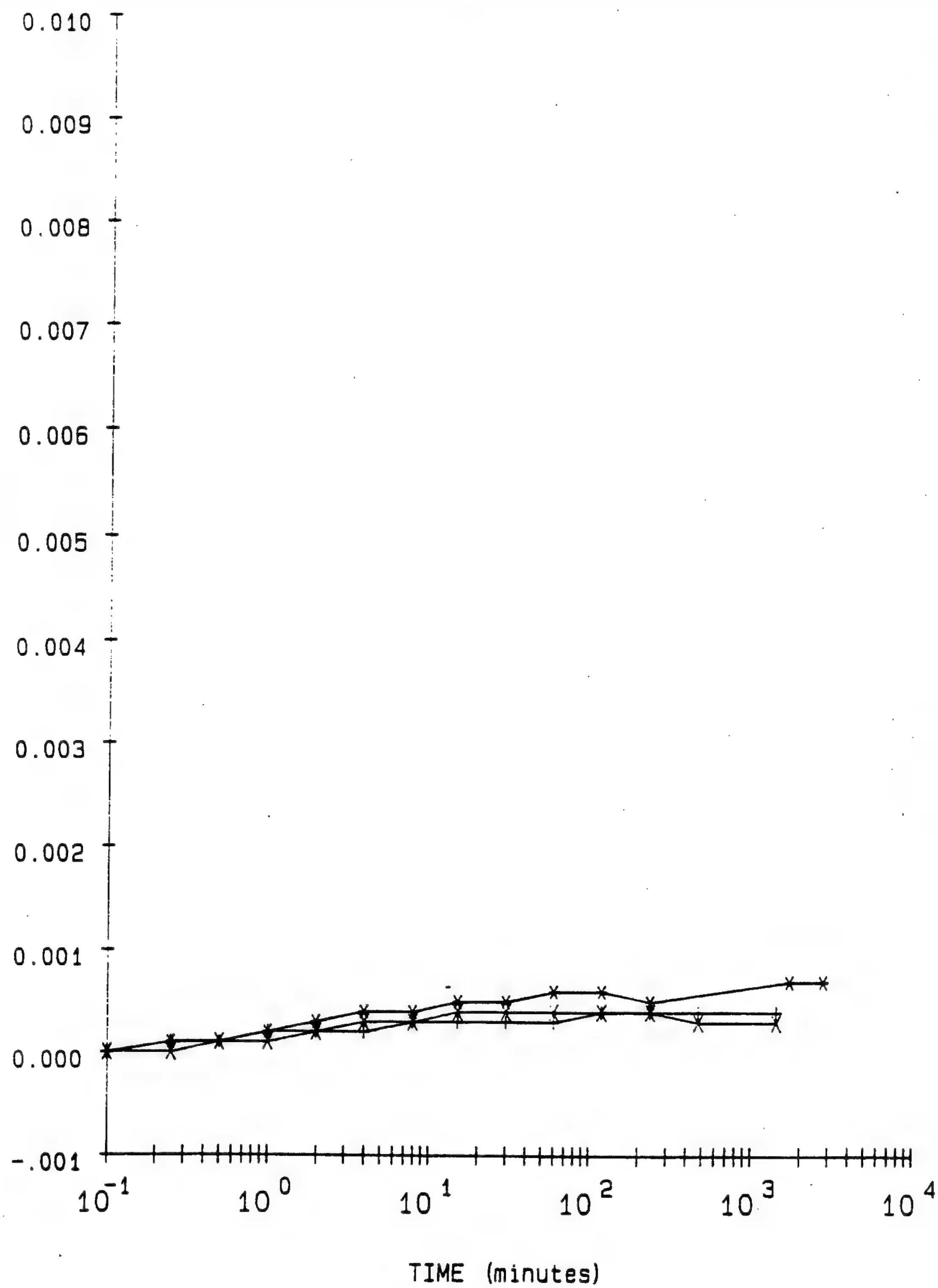
FIGURE 34



LEGEND	
+ =	1 TSF
* =	2 TSF
X =	4 TSF
- =	8 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-110 MU
SAMPLE NO.	S-4
DEPTH/ELEV	31'-33'
MRD LAB NO.	90/135

FIGURE 35



LEGEND

\+ = 2 TSF Rebound

* = .5 TSF Rebound

X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-110 MU
SAMPLE NO.	S-4
DEPTH/ELEV	31'-33'
MRD LAB NO.	90/135

FIGURE 36

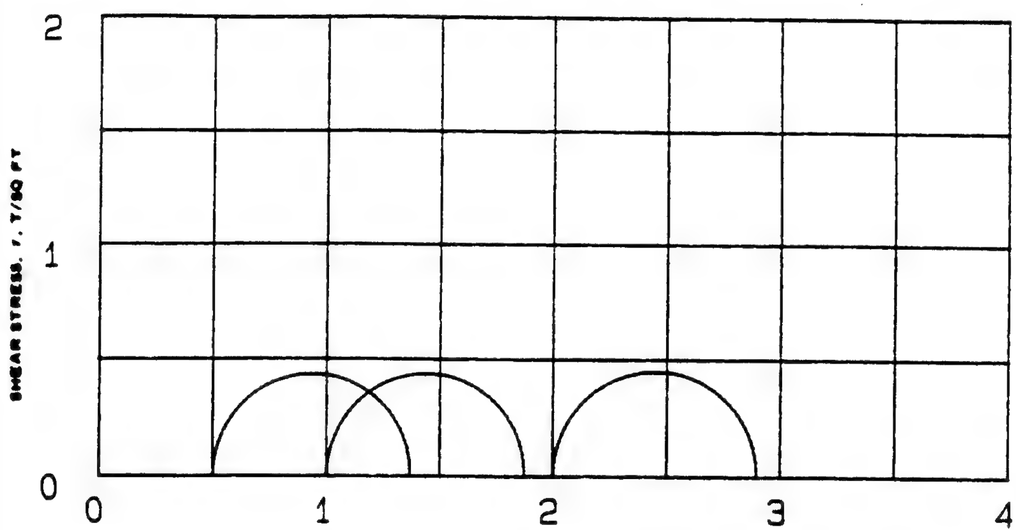
Consolidation Test Data

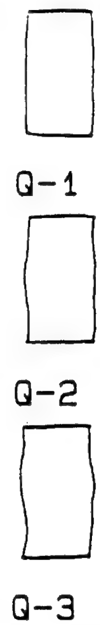
Project	MINNESOTA RIVER; IA-90-04-ED-GH
Boring No.	89-110 MU
Sample No.	S-4
Depth/Elev	31'-33'
MRD Lab No.	90/135

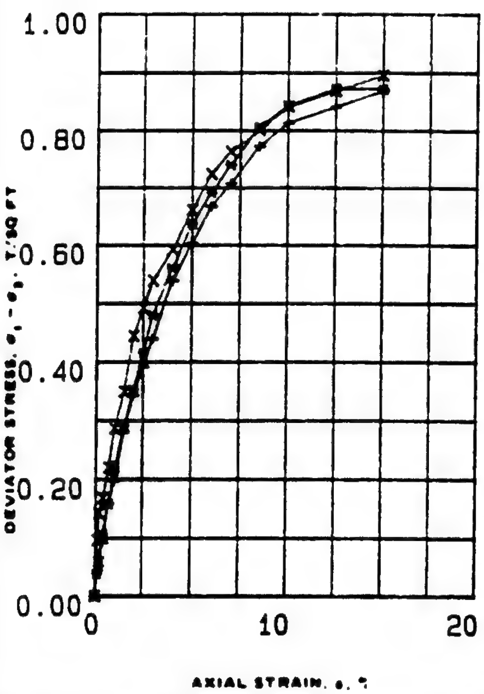
Gs = 2.68
eo = 1.773
0.42eo = 0.745

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
29.6	58.3	60.3	1.773		44.8
23.7	58.3	60.7	1.757	0.10	36.2
23.7	58.3	60.9	1.745	0.25	36.5
23.7	58.3	61.2	1.732	0.50	36.7
23.7	58.3	61.6	1.713	1.00	37.1
23.7	58.3	62.2	1.691	2.00	37.6
23.7	58.3	62.6	1.670	4.00	38.1
23.7	58.3	63.3	1.640	8.00	38.8
23.7	58.3	63.3	1.642	2.00	38.8
23.7	58.3	63.2	1.644	0.50	38.7
23.7	58.3	63.2	1.645	0.10	38.7

Axial Strain (%)	Void Ratio
1	1.746
2	1.718
3	1.690
4	1.662
5	1.635
6	1.607
7	1.579







SPECIMEN NO.			1 (+)	2 (x)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	28.9	28.6	30.8	
	DRY DENSITY LB/CU FT	γd_o	95.5	94.2	92.3	
	SATURATION, %	S_o	100.0	99.0	100.0	
	VOID RATIO	e_o	0.75	0.78	0.81	
BEFORE SHEAR	WATER CONTENT, %	w_c	28.6	28.5	30.3	
	DRY DENSITY LB/CU FT	γd_c	96.2	94.8	92.6	
	SATURATION, %	S_c	100.0	100.0	100.0	
	VOID RATIO	e_c	0.74	0.77	0.81	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.87	0.87	0.90	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	31.5	26.5	32.0	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.87	0.87	0.90	
INITIAL DIAMETER, IN.		D_o	1.40	1.41	1.40	
INITIAL HEIGHT, IN.		H_o	2.94	2.97	2.97	

CONTROLLED- STRAIN TEST

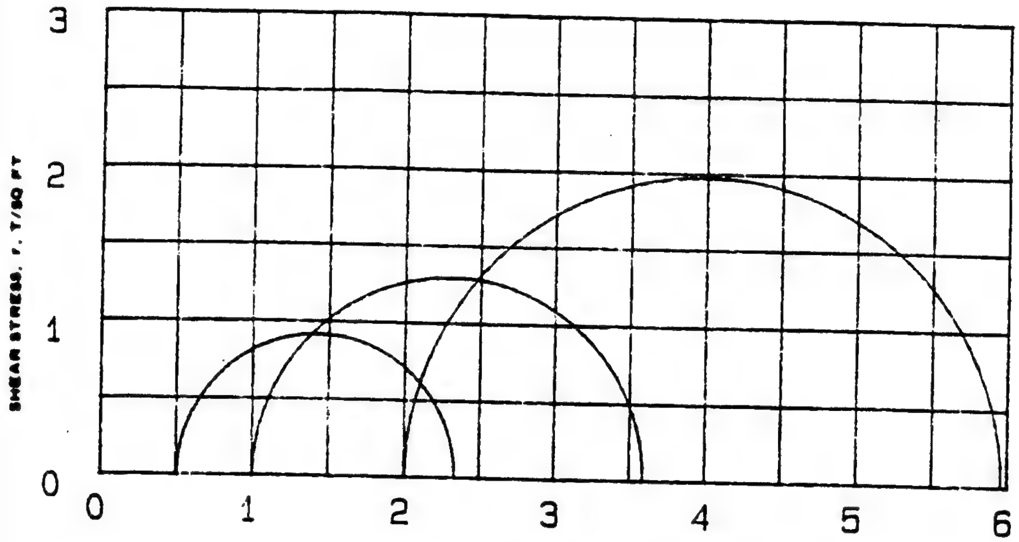
DESCRIPTION OF SPECIMENS Sandy clay, CL

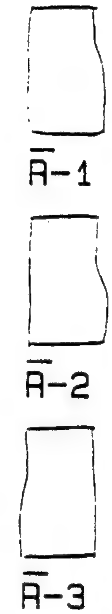
LL 38	PL 19	PI 19	Gs 2.68	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

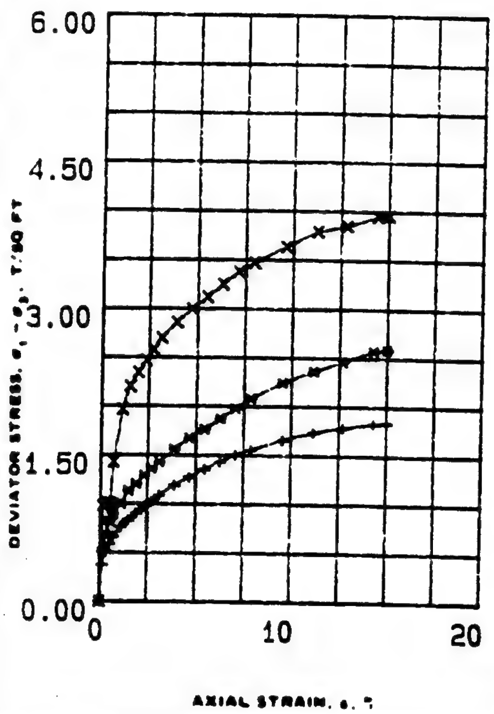
REMARKS: Brown	PROJECT MINNESOTA RIVER; IA-80-04-ED-GH	
Torvane=0.26 TSF		
Non-calcareous	BORING NO. 80-110 MU	SAMPLE NO. S-4
	DEPTH ELEV 31'-33'	
	LABORATORY 80/135	DATE
	TRIAXIAL COMPRESSION TEST REPORT	

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 37







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	28	27.7	28.3	
	DRY DENSITY LB/CU FT	γd_o	96	96.1	95.3	
	SATURATION, %	S_o	100	100	100	
	VOID RATIO	e_o	.74	.74	.76	
BEFORE SHEAR	WATER CONTENT, %	w_c	25.9	24.6	24.5	
	DRY DENSITY LB/CU FT	γd_c	99.2	101.2	101.3	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.69	.65	.65	
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.543	5.543	5.543	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.835	2.591	3.960	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1130	1131	1122	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.835	2.591	3.960	
INITIAL DIAMETER, IN.		D_o	1.41	1.39	1.4	
INITIAL HEIGHT, IN.		H_o	2.97	2.99	2.98	

CONTROLLED- STRAIN TEST

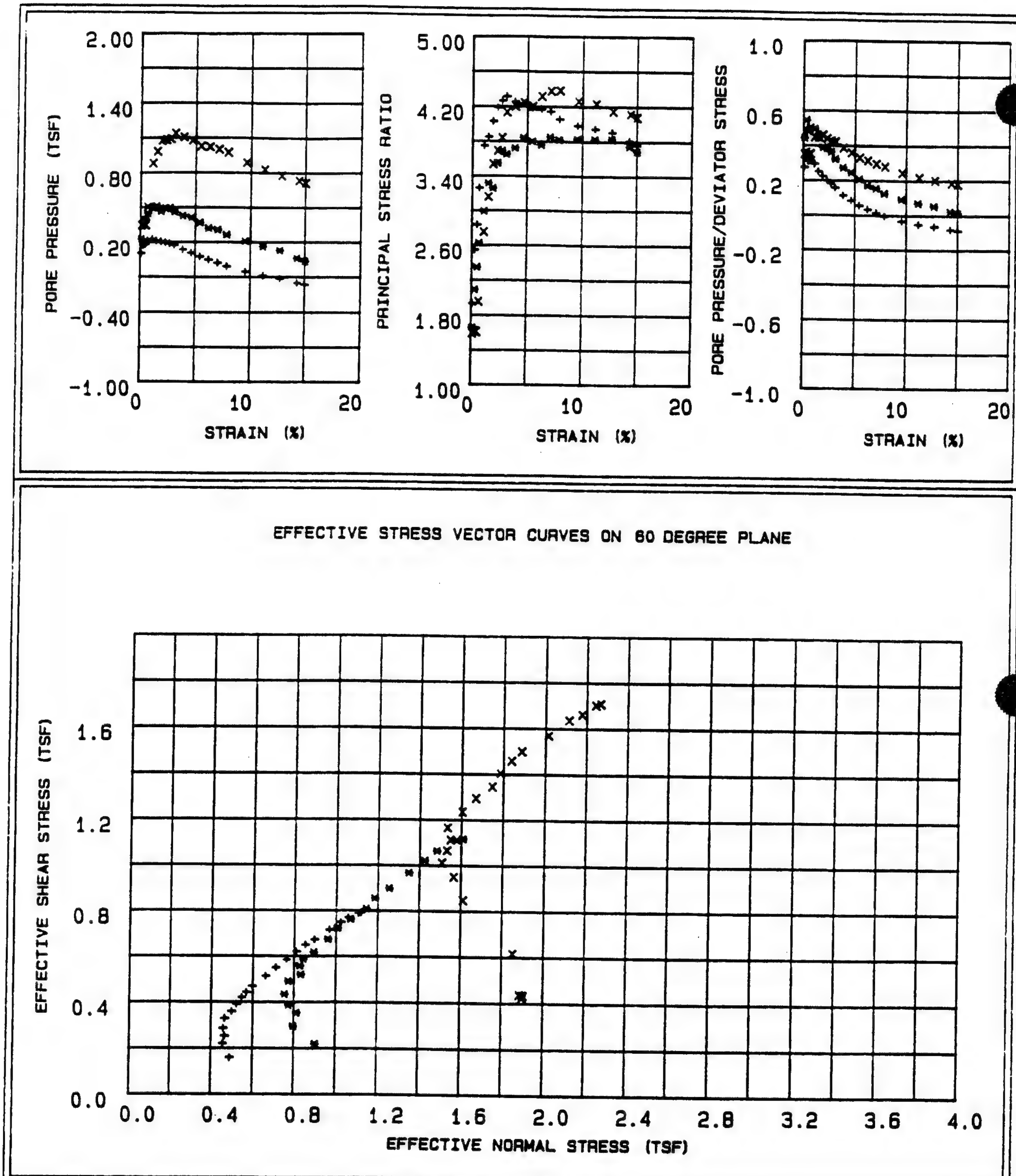
DESCRIPTION OF SPECIMENS Sandy clay, CL B-value 1.0 1.0 1.0

LL 38	PL 19	PI 19	G_s 2.68	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Brown	PROJECT MINNESOTA RIVER; IA-90-04-ED-GH
Torvane=0.26 TSF	
Non-calcareous	BORING NO. 89-110 MU — SAMPLE NO. S-4
	DEPTH ELEV 31'-33'
	LABORATORY 90/135 — DATE
	TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 38



LEGEND

+ = .5 TSF

* = 1 TSF

X = 2 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-110 MU
SAMPLE NO.	S-4
DEPTH/ELEV	31'-33'
MRD LAB NO.	90/135

FIGURE 39

R

Table 13 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-110 MU
Sample Number : S-4
Depth : 31'-33'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.14	0.372	0.102	1.933	0.275	0.490	0.160
30	0.31	0.510	0.170	2.547	0.334	0.456	0.220
45	0.51	0.587	0.180	2.835	0.308	0.465	0.253
60	0.70	0.663	0.207	3.260	0.313	0.457	0.286
90	1.11	0.761	0.223	3.748	0.294	0.465	0.328
120	1.49	0.833	0.208	3.850	0.250	0.498	0.359
150	1.90	0.903	0.202	4.029	0.224	0.522	0.390
180	2.32	0.973	0.195	4.187	0.200	0.546	0.420
210	2.70	1.026	0.185	4.262	0.181	0.569	0.443
240	3.11	1.086	0.172	4.314	0.159	0.597	0.469
300	3.88	1.189	0.134	4.254	0.114	0.660	0.513
360	4.65	1.274	0.106	4.232	0.084	0.709	0.550
420	5.45	1.356	0.074	4.185	0.055	0.762	0.585
[illegible]	6.24	1.436	0.047	4.170	0.033	0.809	0.620
[illegible]	7.07	1.506	0.020	4.141	0.014	0.853	0.650
600	7.89	1.558	-0.010	4.055	-0.006	0.896	0.673
720	9.55	1.658	-0.056	3.982	-0.033	0.967	0.716
840	11.16	1.739	-0.091	3.944	-0.052	1.021	0.750
960	12.71	1.786	-0.115	3.904	-0.064	1.057	0.771
1080	14.30	1.829	-0.151	3.810	-0.082	1.104	0.789
1129	15.00	1.835	-0.165	3.760	-0.089	1.119	0.792

Table 14 - Triaxial $\bar{R}$ Test Results

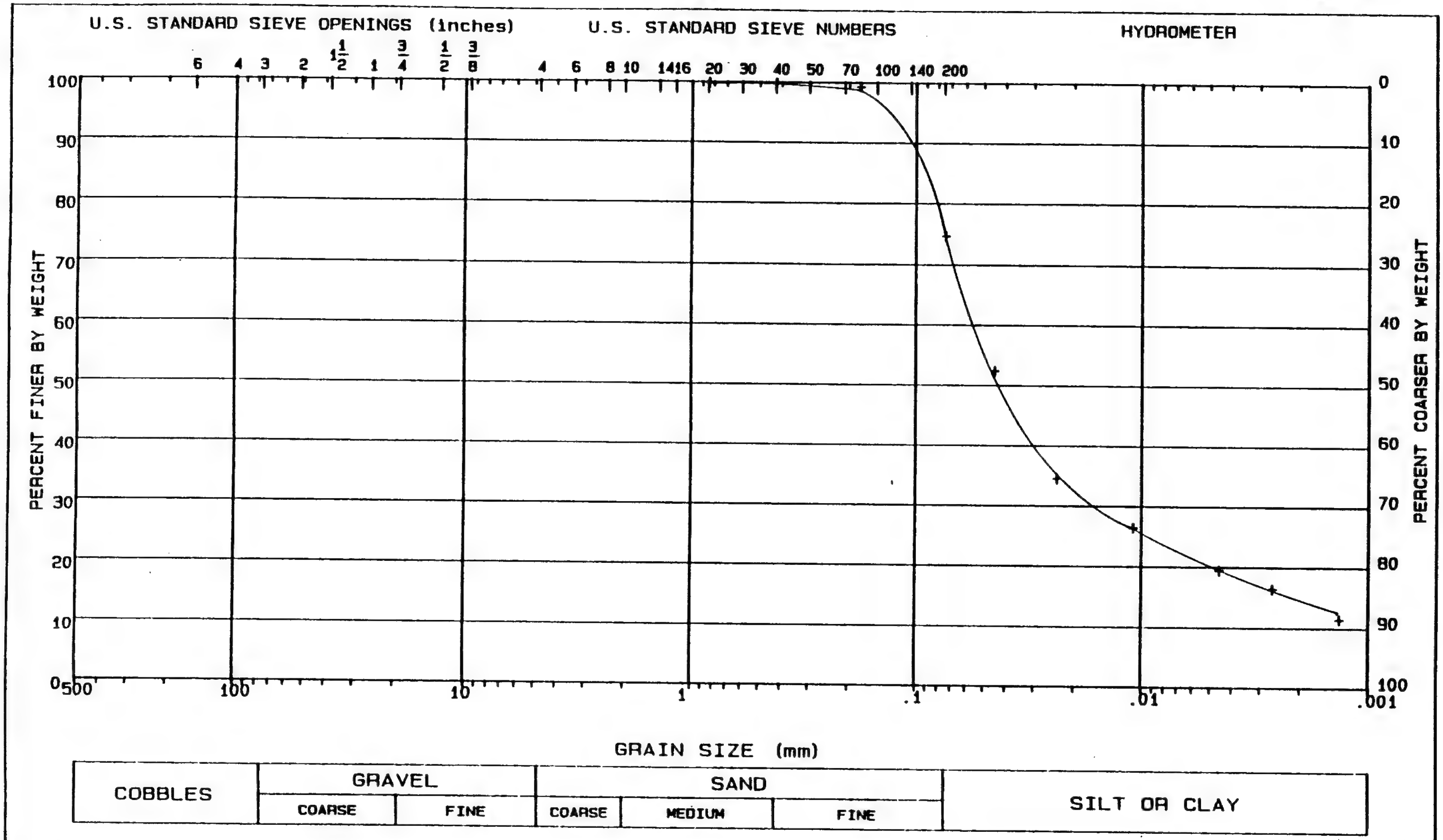
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-110 MU
Sample Number : S-4
Depth : 31'-33'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.14	0.507	0.224	1.654	0.442	0.902	0.219
30	0.31	0.684	0.373	2.091	0.546	0.796	0.295
45	0.51	0.819	0.392	2.348	0.480	0.811	0.354
60	0.70	0.895	0.450	2.627	0.503	0.772	0.386
90	1.11	1.005	0.496	2.993	0.494	0.753	0.434
120	1.49	1.135	0.510	3.319	0.450	0.771	0.490
150	1.90	1.205	0.466	3.257	0.388	0.832	0.520
180	2.31	1.293	0.493	3.549	0.382	0.827	0.558
210	2.70	1.362	0.494	3.692	0.363	0.843	0.588
240	3.11	1.429	0.460	3.648	0.323	0.894	0.617
300	3.88	1.563	0.426	3.725	0.273	0.961	0.675
360	4.65	1.676	0.410	3.842	0.245	1.005	0.724
420	5.44	1.768	0.369	3.800	0.209	1.069	0.763
480	6.24	1.876	0.320	3.759	0.171	1.144	0.81[illegible]
[illegible]	7.06	1.981	0.305	3.852	0.155	1.185	0.85[illegible]
[illegible]0	7.87	2.084	0.261	3.820	0.126	1.255	0.899
720	9.54	2.246	0.207	3.831	0.092	1.349	0.969
840	11.15	2.367	0.162	3.825	0.069	1.424	1.022
960	12.69	2.467	0.128	3.830	0.053	1.483	1.065
1080	14.28	2.577	0.060	3.743	0.024	1.578	1.112
1131	15.00	2.591	0.035	3.687	0.014	1.607	1.118

Table 15 - Triaxial $\overline{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-110 MU
Sample Number : S-4
Depth : 31'-33'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.14	0.978	0.342	1.589	0.350	1.900	0.422
30	0.32	1.010	0.363	1.617	0.360	1.887	0.436
45	0.51	1.006	0.345	1.608	0.343	1.904	0.434
60	0.70	1.428	0.501	1.953	0.351	1.853	0.616
90	1.12	1.966	0.878	2.752	0.447	1.609	0.848
120	1.51	2.201	0.981	3.159	0.446	1.564	0.950
150	1.92	2.345	1.075	3.536	0.459	1.506	1.012
180	2.33	2.471	1.082	3.690	0.438	1.530	1.066
210	2.72	2.579	1.091	3.838	0.424	1.547	1.113
240	3.14	2.702	1.137	4.131	0.421	1.532	1.166
300	3.91	2.861	1.106	4.201	0.387	1.602	1.235
360	4.69	3.001	1.075	4.245	0.359	1.668	1.295
420	5.49	3.120	1.026	4.204	0.330	1.746	1.346
480	6.29	3.253	1.020	4.319	0.314	1.785	1.404
5[illegible]	7.12	3.381	0.999	4.377	0.296	1.838	1.459
600	7.95	3.475	0.973	4.382	0.280	1.887	1.500
720	9.62	3.637	0.885	4.261	0.244	2.015	1.570
840	11.25	3.792	0.826	4.231	0.218	2.113	1.637
960	12.80	3.850	0.776	4.145	0.202	2.177	1.662
1080	14.41	3.946	0.734	4.116	0.186	2.243	1.703
1121	15.00	3.960	0.713	4.078	0.180	2.267	1.709



LL = 38	PL = 19	PI = 19	Gs = 2.68	NAT w = %

CLASSIFICATION Sandy clay, CL

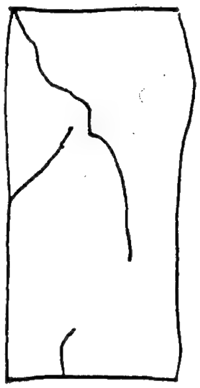
GRADATION CURVE

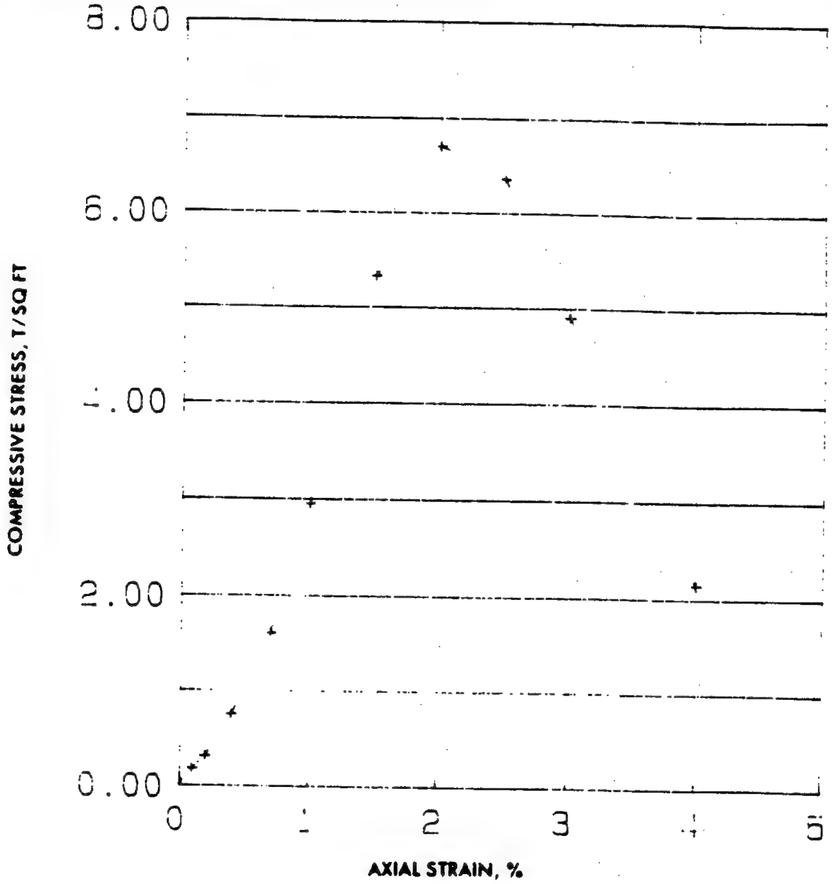
PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-110 MU
SAMPLE NO.	S-4
DEPTH/ELEV	31'-33'
MRD LAB NO.	90/135

FIGURE 40

too brittle for Q or Shear tests

FAILURE SKETCHES





☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN	UNDISTURBED					
INITIAL	WATER CONTENT	w_o	10.2 %	%	%	%
INITIAL	VOID RATIO	e_o	0.42			
INITIAL	SATURATION	S_o	63 %	%	%	%
INITIAL	DRY DENSITY, LB/CU FT	γ_d	115.2			
TIME TO FAILURE, MIN		t_f	8.3			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	6.70			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u				
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.43			
INITIAL SPECIMEN HEIGHT, IN.		H_o	3.01			

CLASSIFICATION Clayey sand, SC

LL	PL	PI	G_s
28	14	14	2.63

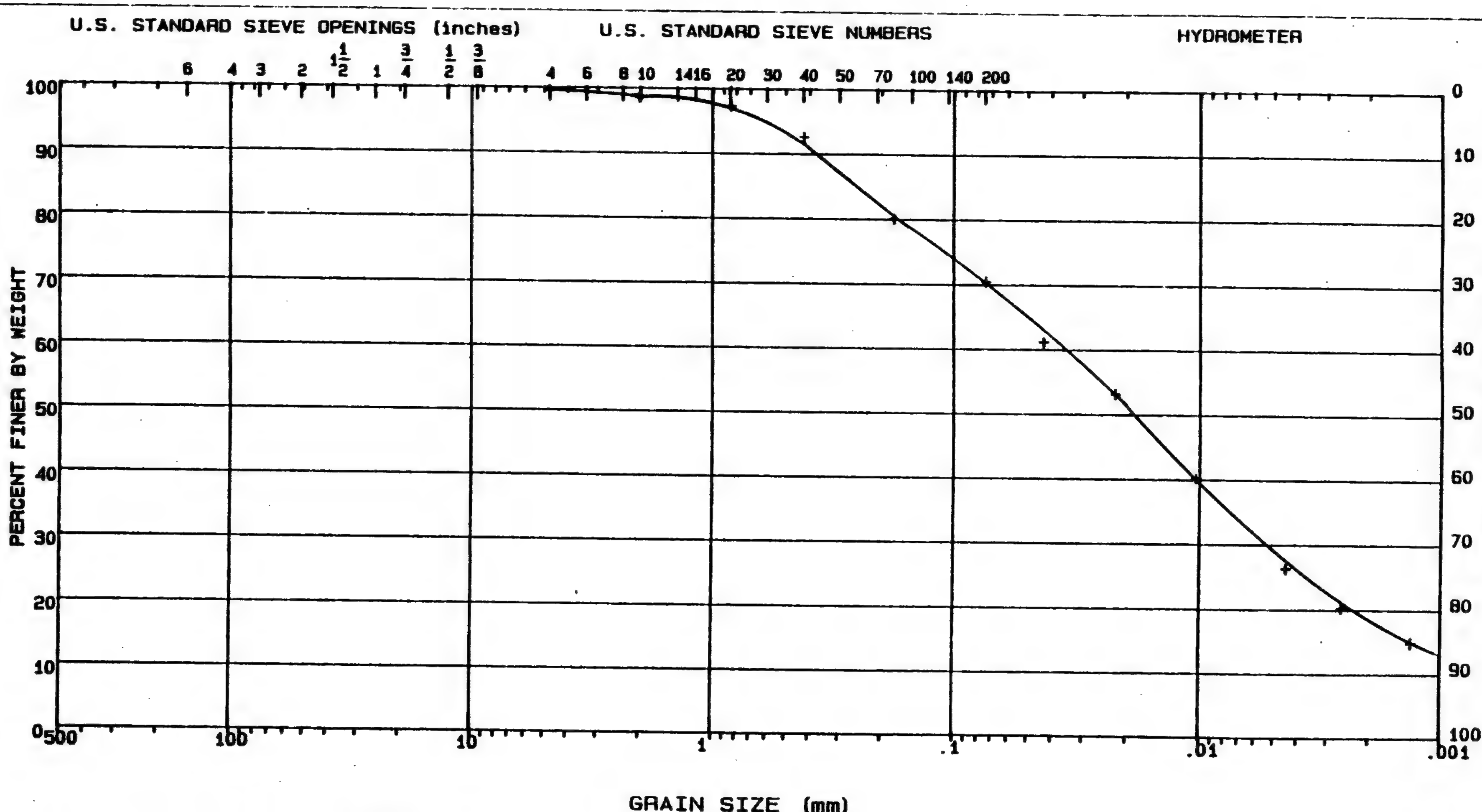
REMARKS Dark brown and tan
Too brittle for Torvane
Highly calcareous

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH		
AREA	MRD LAB NO. : 90/135		
BORING NO.	89-112MU	SAMPLE NO.	S-1
DEPTH EL	3.5'-5.5'	DATE	

UNCONFINED COMPRESSION TEST REPORT

Figure C-359

ENG FORM (TRANSLUCENT)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

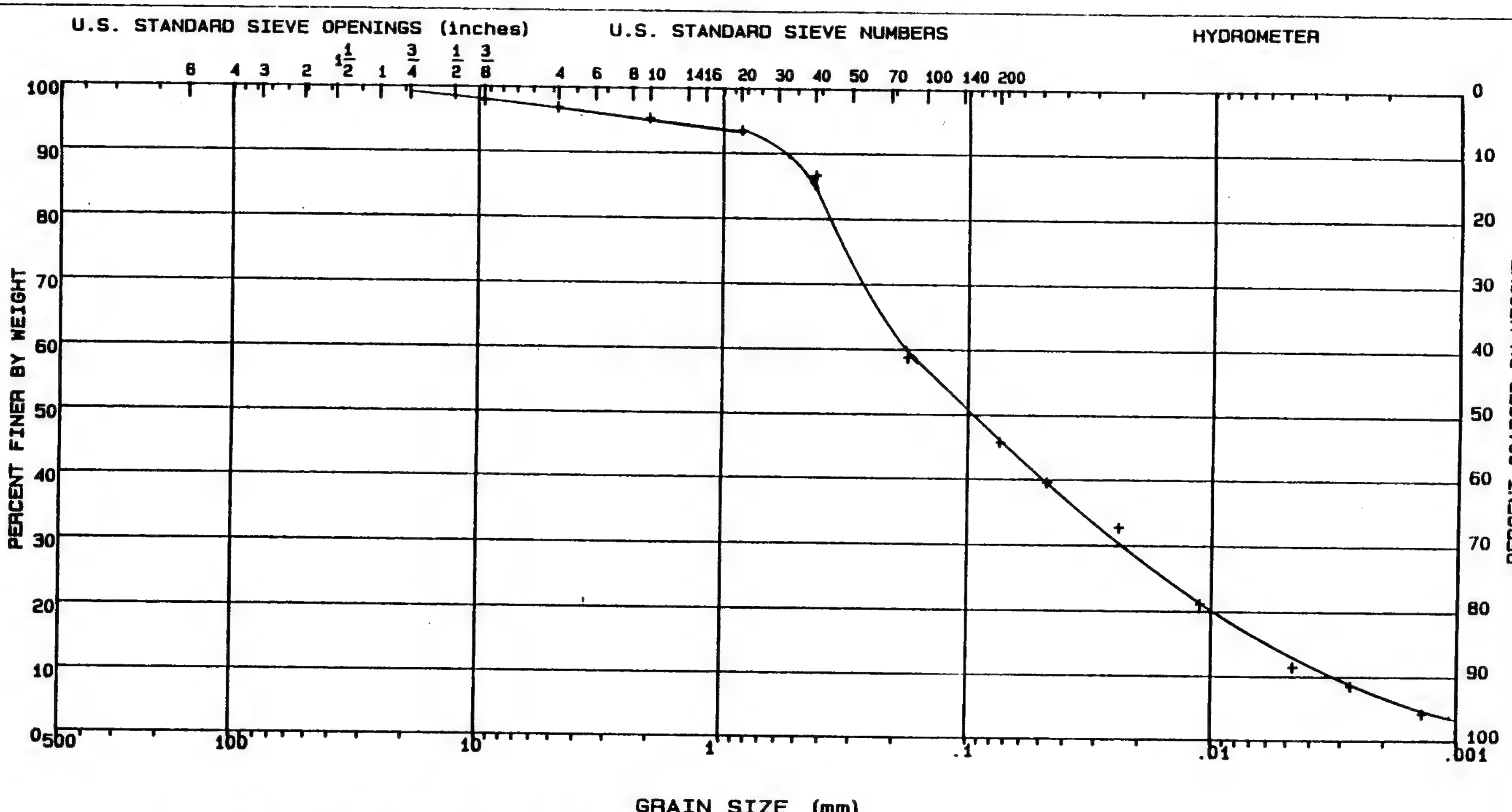
LL = 35	PL = 14	PI = 21	Gs = 2.69	NAT w = %

CLASSIFICATION Sandy clay, CL

GRADATION CURVE

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-112 MU
SAMPLE NO.	S-1
DEPTH/ELEV	3.5'-5.5' (TOP)
MRD LAB NO.	90/135

FIGURE 42



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

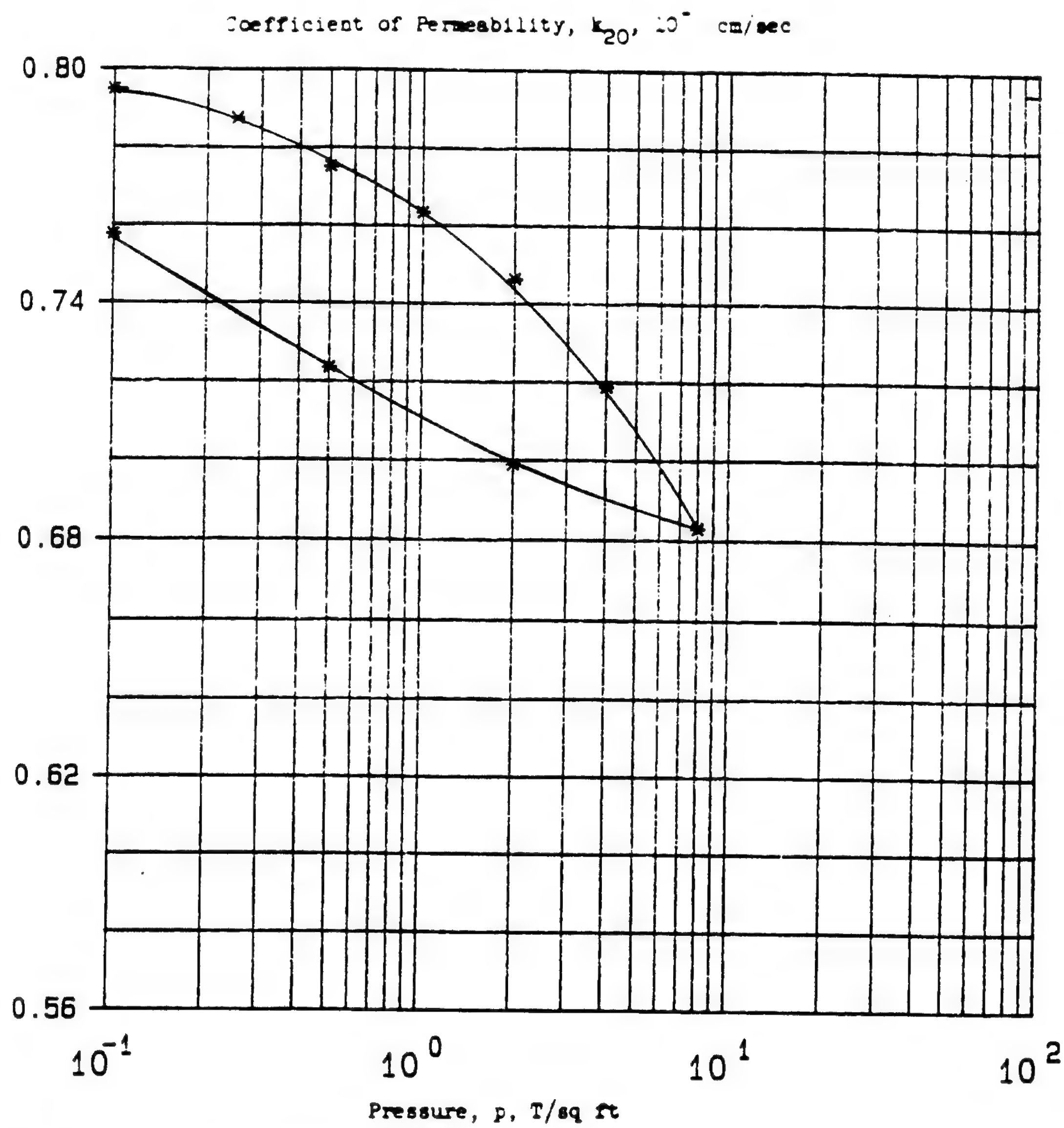
LL = 28	PL = 14	PI = 14	Gs = 2.63	NAT w = %

CLASSIFICATION Clayey sand, SC
Trimming from the
Unconfined Compression Test

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-112 MU
SAMPLE NO.	S-1
DEPTH/ELEV	3.5'-5.5' (BOTTOM)
MRD LAB NO.	90/135

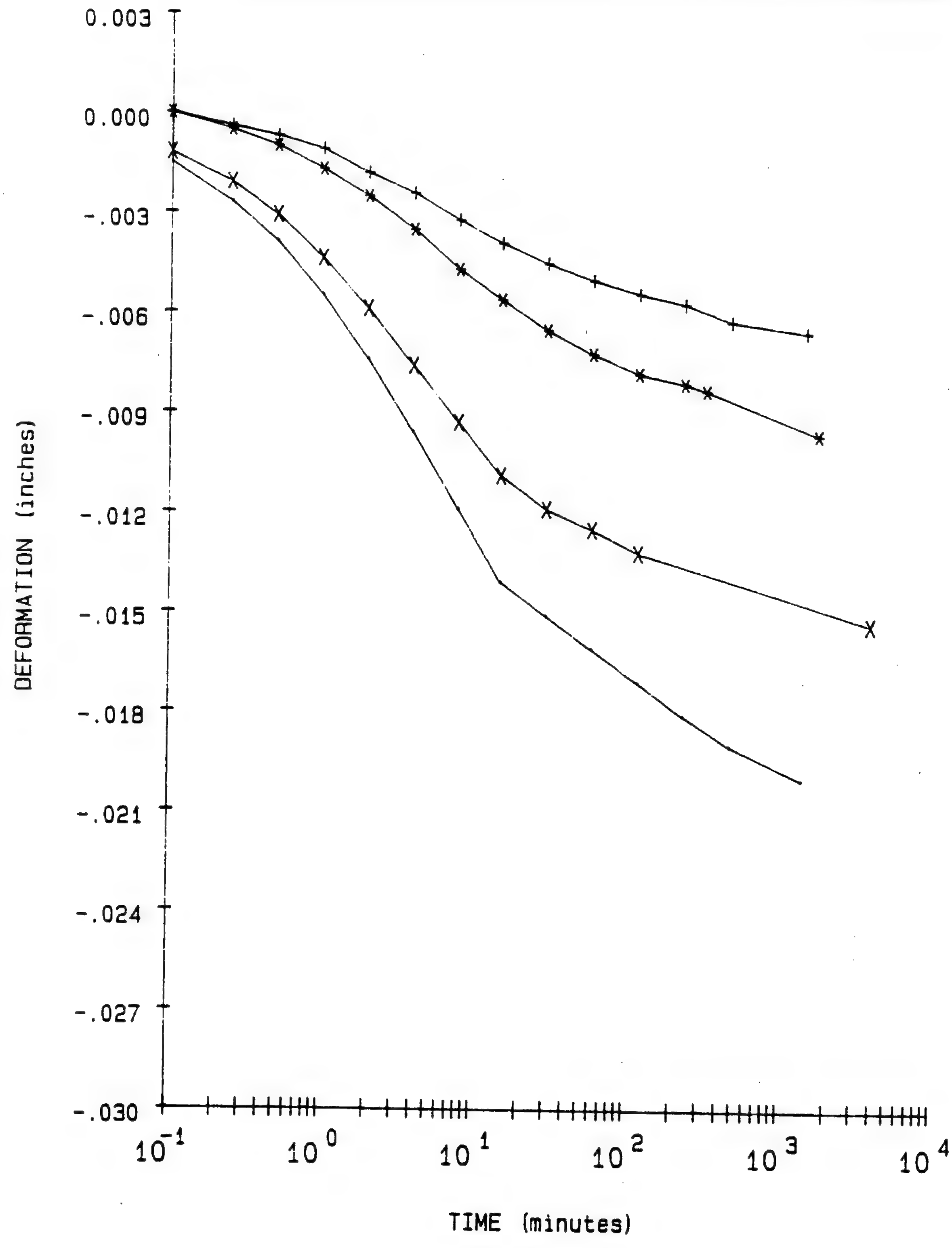
GRADATION CURVE

FIGURE 43



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.3 in.	Ht 1 in.	Water Content, w_o	28.6 %	w_f	26.6 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	0.79	e_f	0.76
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	99 %	S_f	97 %
Compression Index, C_c		Dry Density, γ_d	95.6 lb/ft^3		
Classification Lean clay, CL		k_{20} at e_o = × 10^{-} cm/sec			
LL 44	G_s 2.75	Project	MINNESOTA RIVER: IA-90-04-ED-GH		
PL 19	D_{10}				
Remarks Brown, Gray, Dark Brown		Area	MRO LAB NO. 90/135		
Torvane=0.6 TSF		Boring No.	89-112 MU	Sample No.	S-3
Slightly Calcareous		Depth El	22'-24'	Date	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

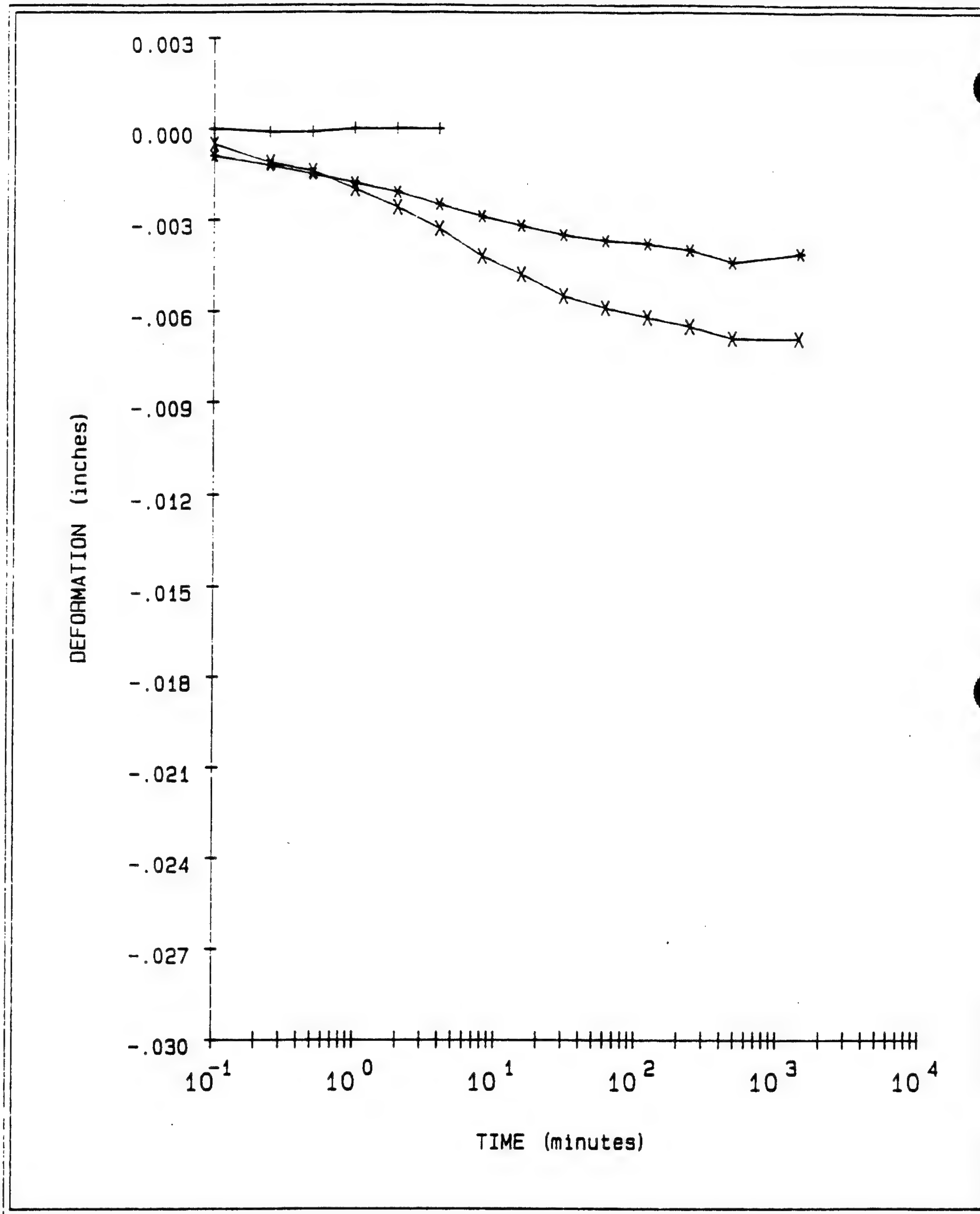


LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF
- = 8 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-112 MU
SAMPLE NO.	S-3
DEPTH/ELEV	22'-24'
MRD LAB NO.	90/135

FIGURE 18

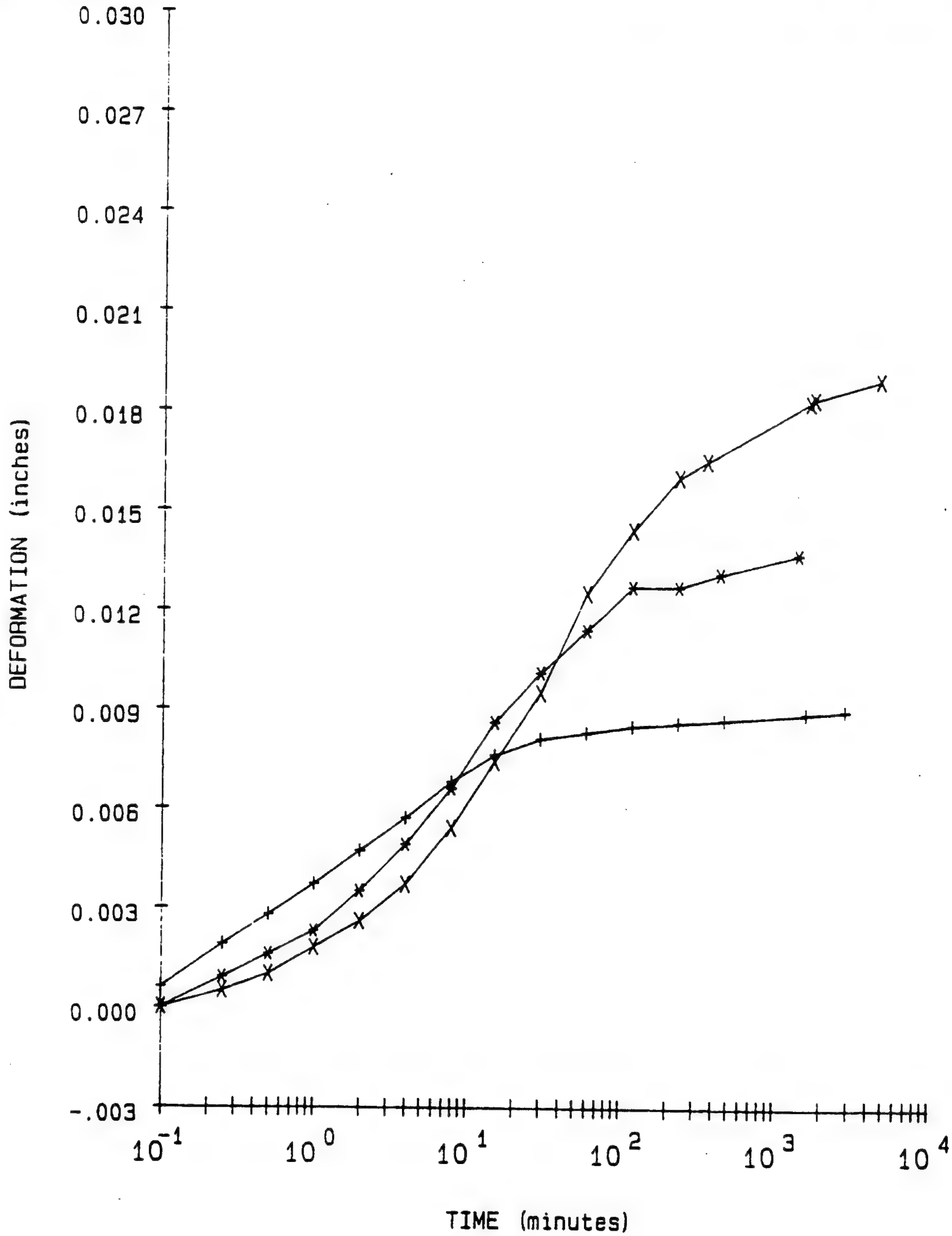


LEGEND

+ = .1 TSF
* = .25 TSF
X = .5 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-112 MU
SAMPLE NO.	S-3
DEPTH/ELEV	22'-24'
MRD LAB NO.	90/135

FIGURE 19



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-112 MU
SAMPLE NO.	S-3
DEPTH/ELEV	22'-24'
MRD LAB NO.	90/135

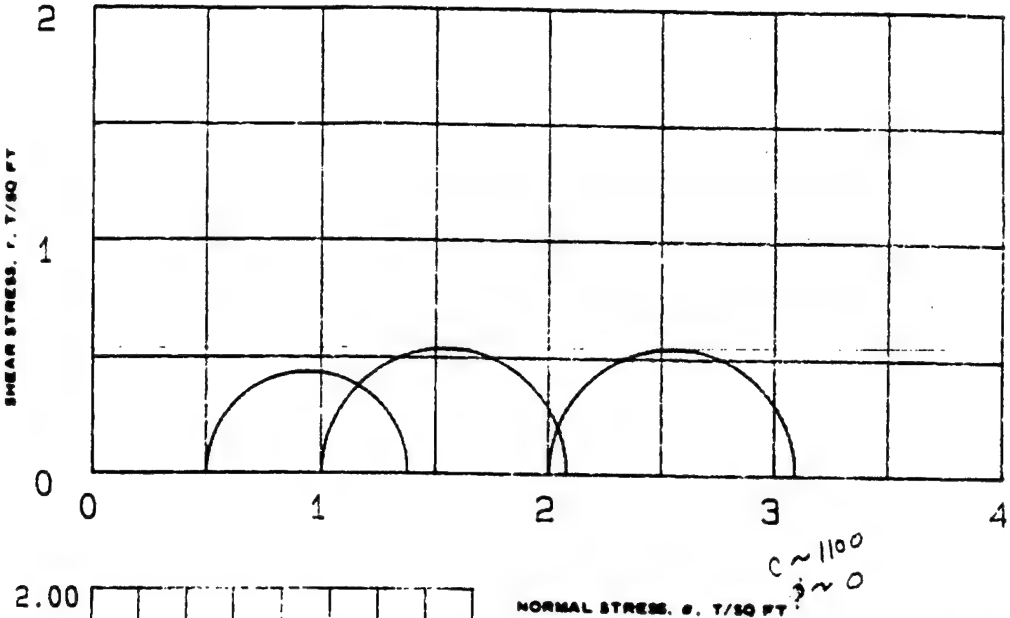
Consolidation Test Data

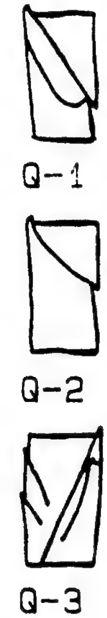
Project	MINNESOTA RIVER; IA-90-04-ED-GH
Boring No.	89-112 MU
Sample No.	S-3
Depth/Elev	22'-24'
MRD Lab No.	90/135

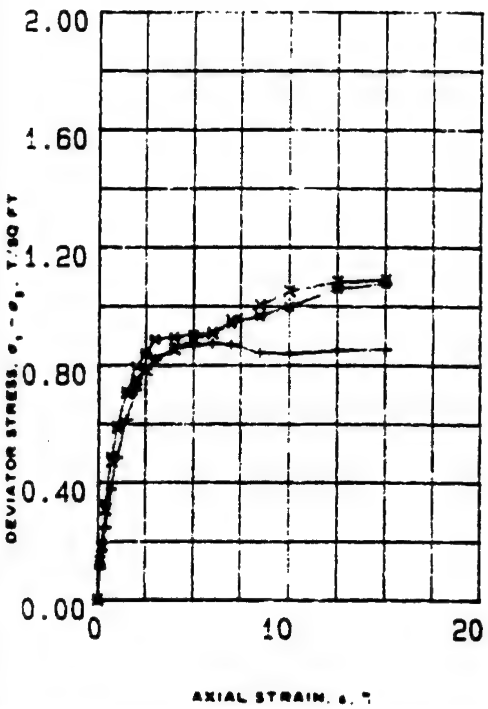
Gs = 2.75
eo = 0.795
0.42eo = 0.334

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
28.6	362.1	95.6	0.795		99.0
26.6	362.1	95.6	0.795	0.10	92.1
26.6	362.1	96.0	0.787	0.25	93.0
26.6	362.1	96.7	0.775	0.50	94.5
26.6	362.1	97.3	0.763	1.00	95.9
26.6	362.1	98.3	0.746	2.00	98.1
26.6	362.1	99.8	0.719	4.00	100.0
26.6	362.1	102.0	0.683	8.00	100.0
26.6	362.1	101.0	0.699	2.00	100.0
26.6	362.1	99.6	0.724	0.50	100.0
26.6	362.1	97.6	0.758	0.10	96.6

Axial Strain (%)	Void Ratio
1	0.777
2	0.759
3	0.741
4	0.723
5	0.705
6	0.687
7	0.669
8	0.651
9	0.633







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	27.4	28.5	28.3	
	DRY DENSITY LB/CU FT	γd_o	98.4	95.3	97.0	
	SATURATION, %	S_o	100.0	98.0	100.0	
	VOID RATIO	e_o	0.75	0.80	0.77	
BEFORE SHEAR	WATER CONTENT, %	w_c	27.2	28.3	28.2	
	DRY DENSITY LB/CU FT	γd_c	98.4	95.3	99.4	
	SATURATION, %	S_c	100.0	97.0	100.0	
	VOID RATIO	e_c	0.75	0.80	0.73	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.88	1.08	1.09	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	13.5	31.0	21.3	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.85	1.08	1.09	
INITIAL DIAMETER, IN.		D_o	1.42	1.42	1.42	
INITIAL HEIGHT, IN.		H_o	3.00	3.00	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL

LL 44	PL 19	PI 25	G_s 2.75	TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	Q

REMARKS: Brown, Gray, Dark Brown
Torvane=0.6 TSF
Slightly Calcareous

PROJECT MINNESOTA RIVER: IA-90-04-ED-GH

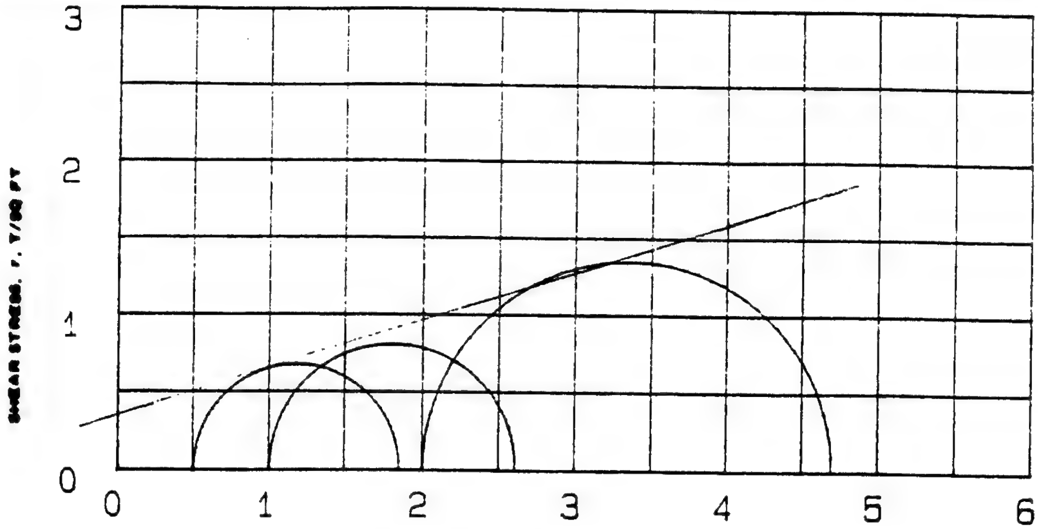
BORING NO. 89-112 MU SAMPLE NO. S-3

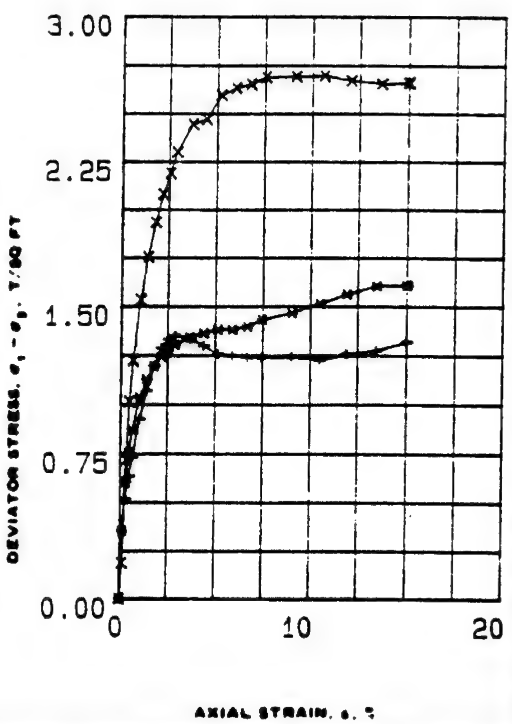
DEPTH ELEV 22'-24'

LABORATORY 90/135 DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 21





SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	29.3	28.1	28.5	
	DRY DENSITY LB/CU FT	γ_{d_o}	95.1	96.5	95.6	
	SATURATION, %	S_o	100	99	99	
	VOID RATIO	e_o	.81	.78	.8	
BEFORE SHEAR	WATER CONTENT, %	w_c	30.2	27.8	26.7	
	DRY DENSITY LB/CU FT	γ_{d_c}	95.9	98.4	99.5	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.79	.74	.73	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.350	1.608	2.697	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	240	1191	840	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.317	1.608	2.560	
INITIAL DIAMETER, IN.		D_o	1.38	1.39	1.4	
INITIAL HEIGHT, IN.		H_o	3	3	2.99	

CONTROLLED- STRAIN TEST

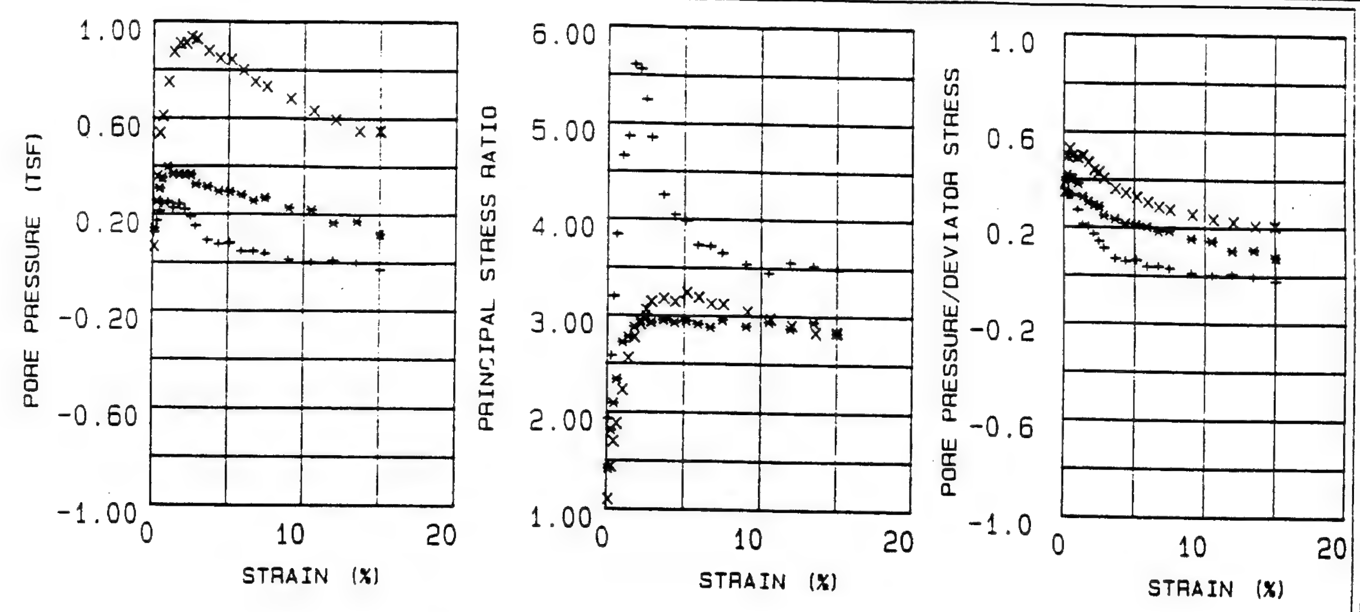
DESCRIPTION OF SPECIMENS Lean clay, CL B-value 1.0 1.0 1.0

LL 44	PL 19	PI 25	G_s 2.75	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST R-BAR

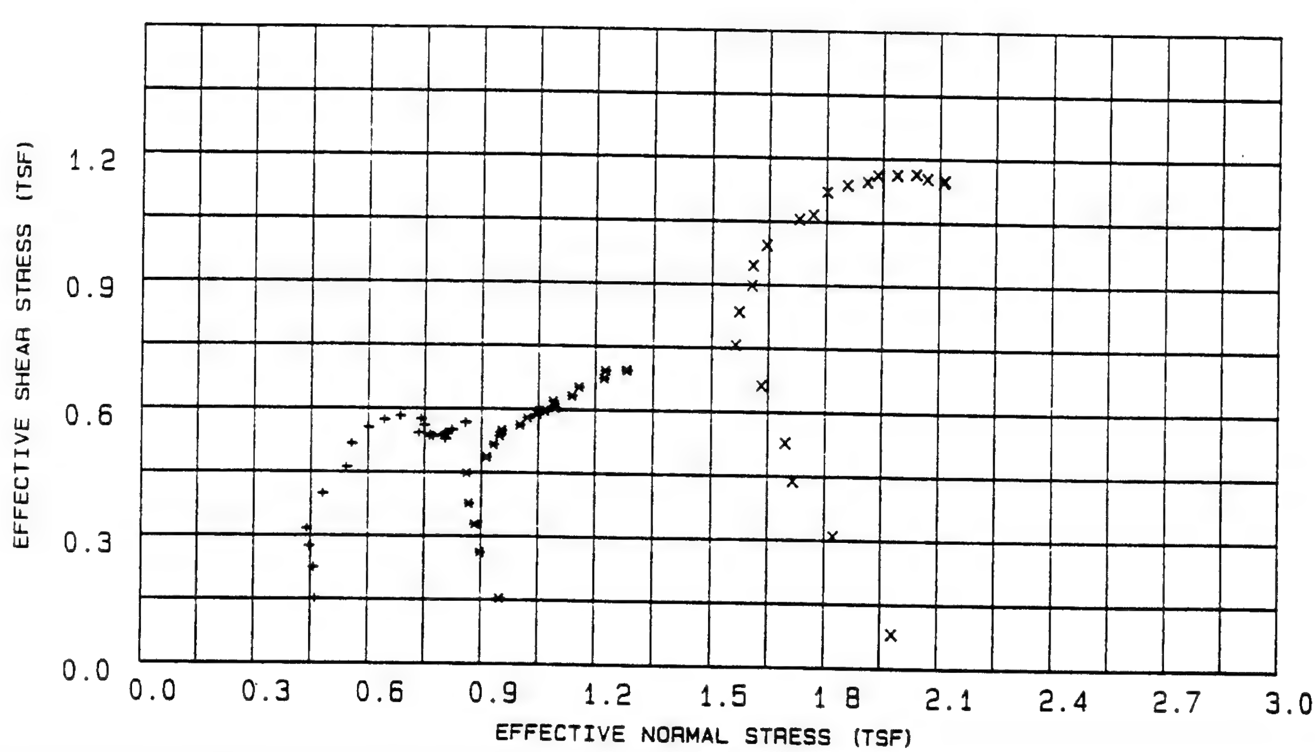
REMARKS: Brown, Gray, Dark Brown	PROJECT MINNESOTA RIVER; IA-90-04-ED-GH
Torvane=0.6 TSF	
Slightly Calcareous	BORING NO 89-112 MU — SAMPLE NO. S-3
	DEPTH ELEV 22'-24'
	LABORATORY 90/135 — DATE
	TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)*

FIGURE 22



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF
* = 1 TSF
X = 2 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-112 MU
SAMPLE NO.	S-3
DEPTH/ELEV	22'-24'
MRD LAB NO.	90/135

FIGURE 23

R

Table 7 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-112 MU
Sample Number : S-3
Depth : 22'-24'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.348	0.124	1.926	0.356	0.462	0.150
30	0.31	0.518	0.171	2.578	0.331	0.457	0.224
45	0.48	0.634	0.212	3.199	0.334	0.445	0.274
60	0.65	0.731	0.242	3.837	0.332	0.439	0.315
90	1.03	0.923	0.248	4.658	0.269	0.481	0.398
120	1.39	1.069	0.223	4.864	0.209	0.542	0.461
150	1.78	1.196	0.240	5.604	0.201	0.556	0.516
180	2.16	1.286	0.218	5.559	0.170	0.600	0.555
210	2.52	1.331	0.186	5.242	0.140	0.643	0.574
240	2.86	1.350	0.149	4.848	0.111	0.685	0.583
300	3.65	1.332	0.090	4.247	0.068	0.740	0.575
360	4.37	1.297	0.073	4.039	0.057	0.748	0.560
420	5.11	1.255	0.078	3.975	0.063	0.733	0.542
[illegible]	5.88	1.246	0.043	3.729	0.035	0.765	0.538
5[illegible]	6.67	1.237	0.044	3.715	0.036	0.762	0.534
600	7.44	1.236	0.033	3.646	0.027	0.773	0.534
720	9.00	1.242	0.010	3.533	0.008	0.798	0.536
840	10.49	1.224	-0.001	3.443	0.000	0.804	0.528
960	11.91	1.256	0.008	3.555	0.007	0.803	0.542
1080	13.44	1.274	-0.005	3.522	-0.004	0.821	0.550
1192	15.00	1.317	-0.030	3.484	-0.023	0.857	0.568
1192	15.00	1.317	-0.030	3.484	-0.023	0.857	0.568

Table 8 - Triaxial $\bar{R}$ Test Results

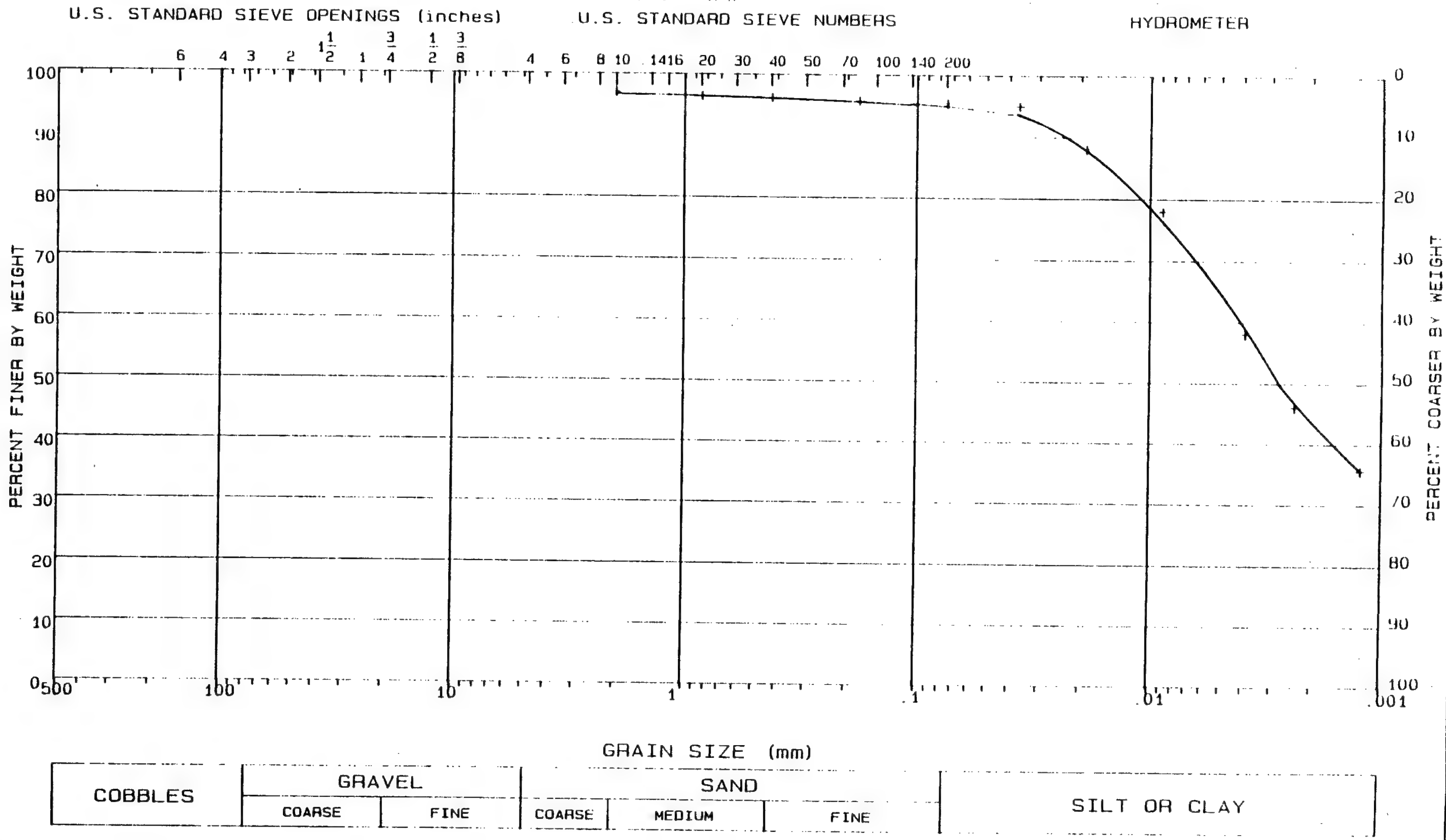
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-112 MU
Sample Number : S-3
Depth : 22'-24'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.355	0.139	1.412	0.392	0.949	0.153
30	0.31	0.605	0.253	1.811	0.419	0.897	0.261
45	0.48	0.758	0.305	2.090	0.402	0.883	0.327
60	0.65	0.871	0.349	2.337	0.401	0.867	0.376
90	1.03	1.038	0.396	2.719	0.382	0.861	0.448
120	1.39	1.127	0.366	2.778	0.325	0.913	0.486
150	1.78	1.196	0.364	2.881	0.305	0.932	0.516
180	2.17	1.244	0.361	2.947	0.290	0.947	0.537
210	2.52	1.275	0.363	3.000	0.285	0.953	0.550
240	2.86	1.305	0.322	2.925	0.247	1.001	0.563
300	3.65	1.343	0.312	2.951	0.232	1.021	0.580
360	4.38	1.364	0.292	2.927	0.215	1.046	0.589
420	5.12	1.383	0.289	2.944	0.209	1.053	0.597
480	5.89	1.383	0.276	2.911	0.200	1.066	0.597
5[illegible]	6.68	1.400	0.253	2.875	0.182	1.094	0.604
6[illegible]	7.46	1.435	0.266	2.955	0.186	1.089	0.619
720	9.02	1.467	0.224	2.889	0.153	1.139	0.633
840	10.51	1.516	0.217	2.935	0.143	1.158	0.654
960	11.93	1.564	0.164	2.870	0.105	1.223	0.675
1080	13.47	1.606	0.171	2.937	0.107	1.227	0.693
1190	15.00	1.608	0.117	2.822	0.074	1.281	0.694
1190	15.00	1.608	0.117	2.822	0.074	1.281	0.694

Table 9 - Triaxial $\overline{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-112 MU
Sample Number : S-3
Depth : 22'-24'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.186	0.065	1.096	0.347	1.981	0.080
30	0.32	0.717	0.354	1.436	0.495	1.823	0.309
45	0.48	1.015	0.536	1.694	0.528	1.715	0.438
60	0.66	1.224	0.608	1.880	0.497	1.695	0.528
90	1.04	1.533	0.749	2.226	0.489	1.631	0.662
120	1.41	1.753	0.872	2.554	0.498	1.562	0.756
150	1.80	1.934	0.908	2.772	0.470	1.571	0.835
180	2.19	2.080	0.910	2.908	0.438	1.605	0.898
210	2.55	2.190	0.935	3.057	0.428	1.607	0.945
240	2.89	2.300	0.926	3.143	0.403	1.643	0.993
300	3.69	2.445	0.877	3.177	0.359	1.728	1.055
360	4.42	2.471	0.847	3.143	0.343	1.765	1.066
420	5.18	2.596	0.842	3.242	0.325	1.801	1.120
480	5.96	2.634	0.797	3.190	0.303	1.855	1.137
[illegible]	6.75	2.654	0.749	3.122	0.283	1.908	1.145
[illegible]	7.53	2.690	0.730	3.117	0.272	1.936	1.161
720	9.11	2.693	0.680	3.040	0.253	1.987	1.162
840	10.62	2.697	0.631	2.970	0.234	2.037	1.164
960	12.05	2.671	0.595	2.900	0.223	2.066	1.153
1080	13.61	2.654	0.547	2.826	0.206	2.110	1.145
1179	15.00	2.660	0.547	2.830	0.206	2.112	1.148
1179	15.00	2.660	0.547	2.830	0.206	2.112	1.148



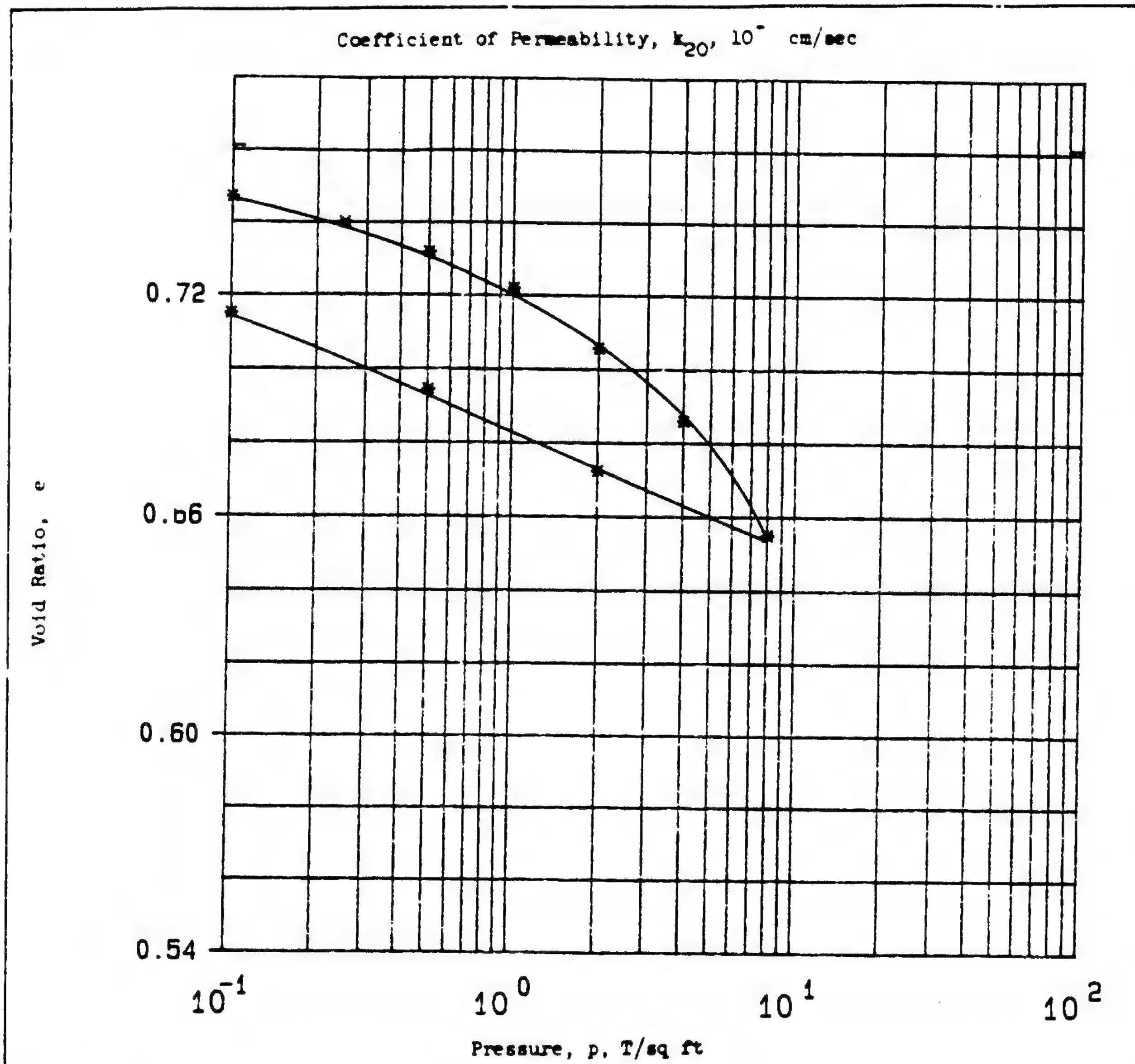
LL = 44	PL = 19	PI = 25	Gs = 2.75	NAT w = %

CLASSIFICATION Lean clay, CL

GRADATION CURVE

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89 112 MU
SAMPLE NO.	S-3
DEPTH/ELEV	22'-24'
MRD LAB NO.	90/135

FIGURE 24



Type of Specimen	UNDISTURBED			Before Test		After Test	
Diam	4.4 in.	Ht	1 in.	Water Content, w_o	26.4 %	w_f	27.9 %
Overburden Pressure, p_o			T/sq ft	Void Ratio, e_o	0.76	e_f	0.71
Preconsol. Pressure, p_c			T/sq ft	Saturation, S_o	95 %	S_f	100 %
Compression Index, C_c				Dry Density, γ_d	97.4 lb/ft^3		
Classification	Lean clay, CL			k_{20} at e_o =	$\times 10^{-}$ cm/sec		

LL	46	G_s	2.75
PL	17	D_{10}	

Remarks Medium gray. Torvane=1.25 TSF. Slightly calcareous.

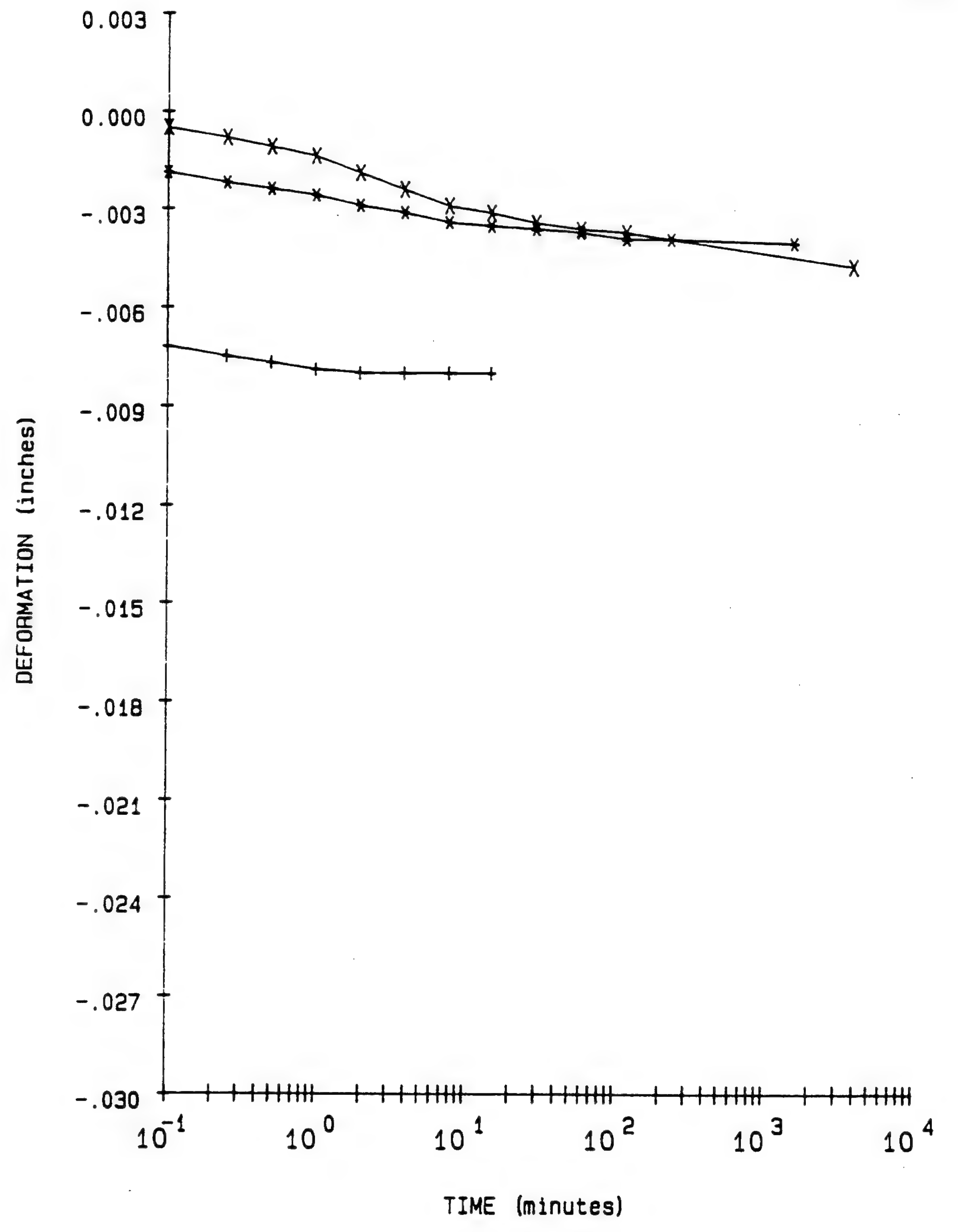
Project	MINNESOTA RIVER: IA-90-04-ED-GH		
Area	MRD LAB NO. 90/135		
Boring No.	89-112 MU	Sample No.	S-4
Depth El	30'-32'	Date	

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE

Figure 1

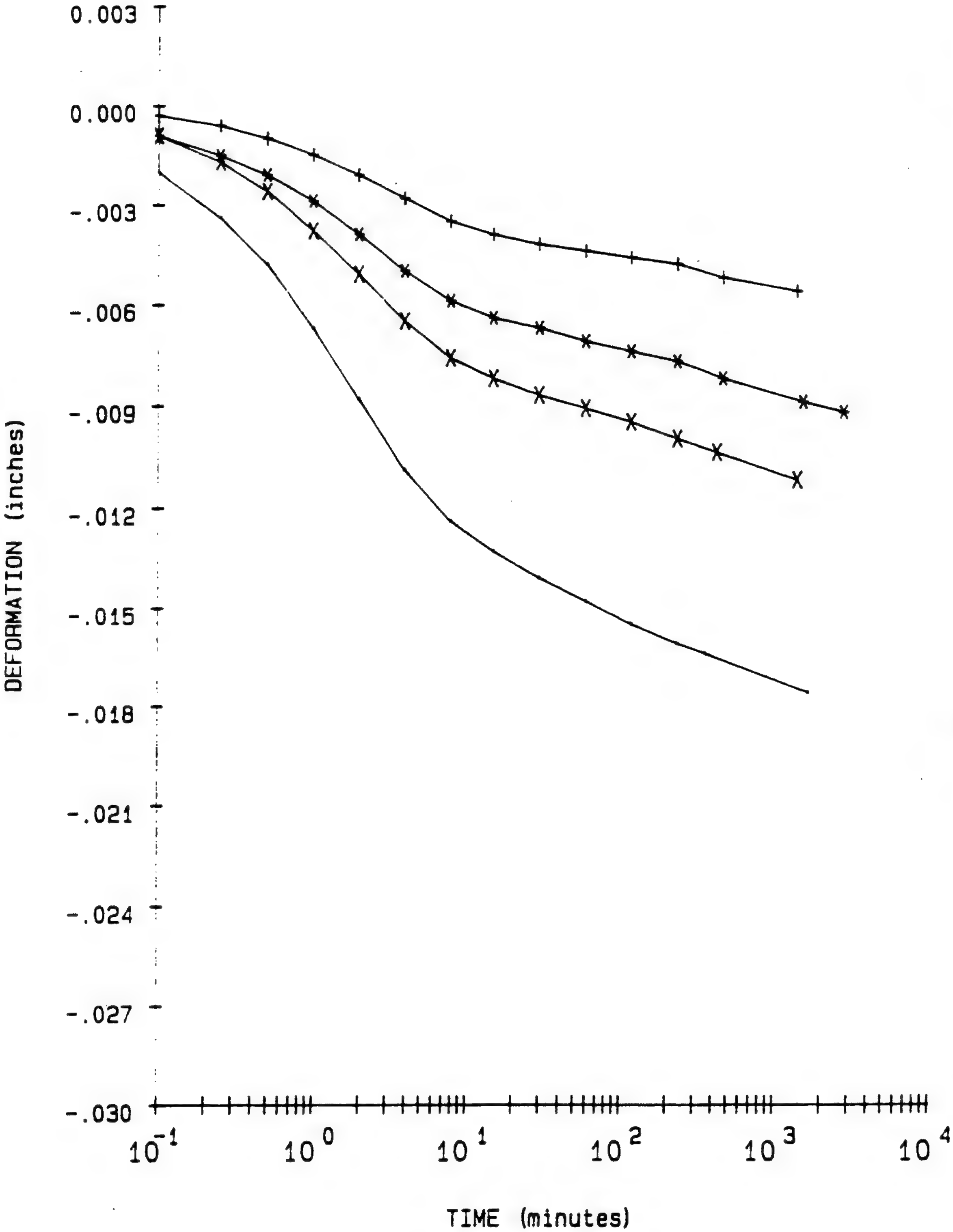
Figure C-374



LEGEND	
+ = .1 TSF	
* = .25 TSF	
X = .5 TSF	

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-112 MU
SAMPLE NO.	S-4
DEPTH/ELEV	30'-32'
MRD LAB NO.	90/135

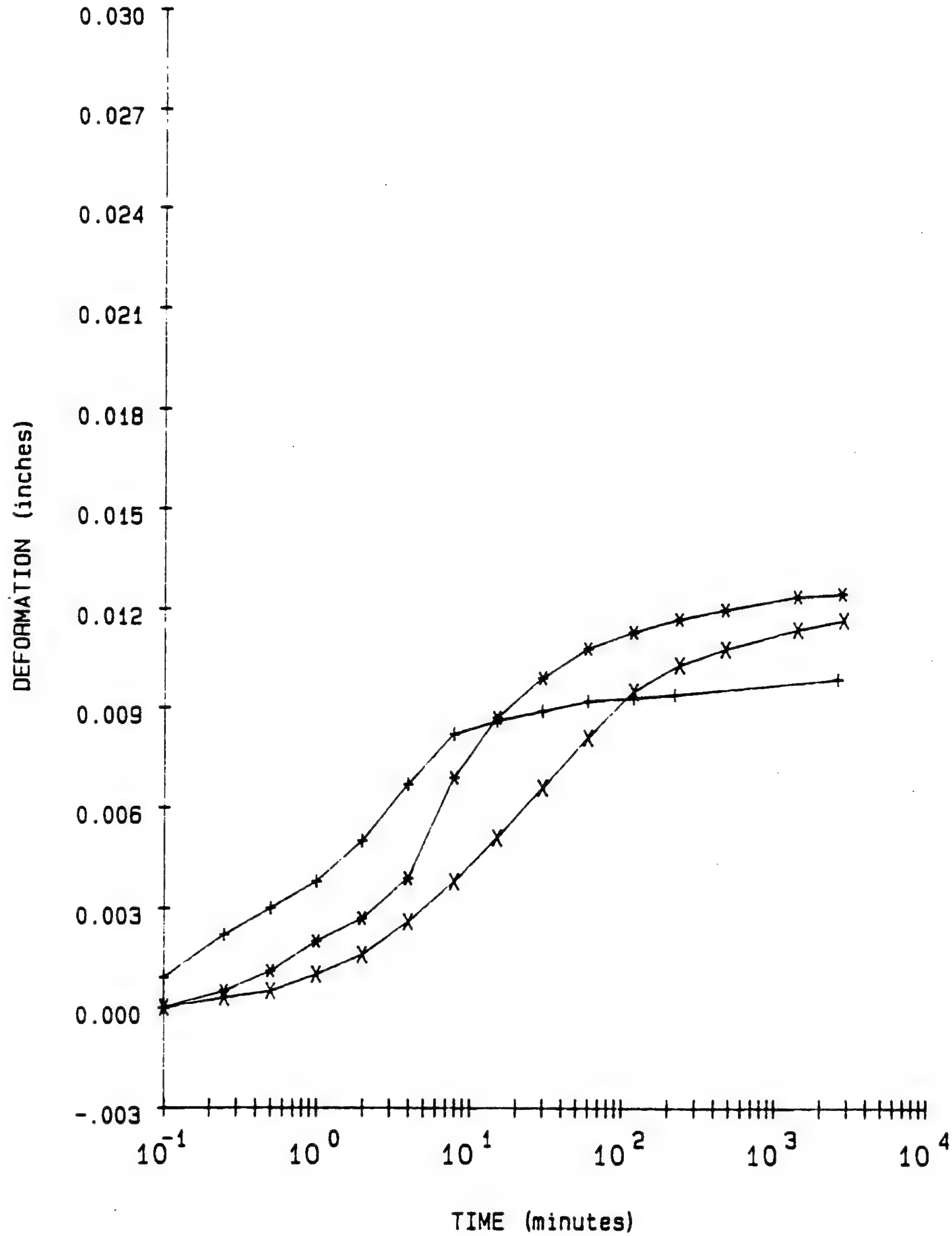
FIGURE 2



LEGEND	
+ = 1	TSF
✱ = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-112 MU
SAMPLE NO.	S-4
DEPTH/ELEV	30'-32'
MRD LAB NO.	90/135

FIGURE 3



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-112 MU
SAMPLE NO.	S-4
DEPTH/ELEV	30'-32'
MRD LAB NO.	90/135

FIGURE 4

Consolidation Test Data

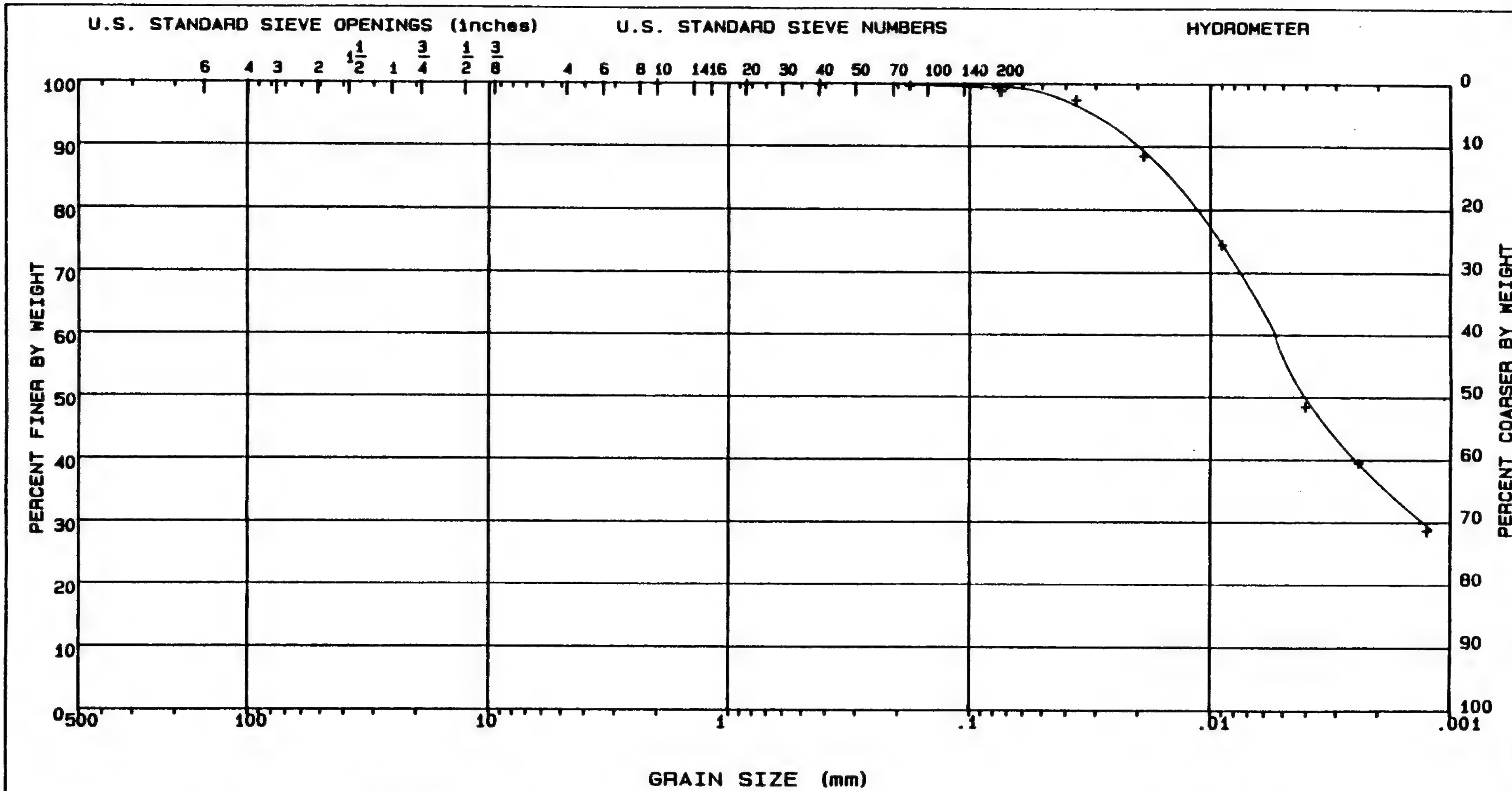
Project MINNESOTA RIVER; IA-90-04-ED-GH

Boring No. 89-112 MU
Sample No. S-4
Depth/Elev 30'-32'
MRD Lab No. 90/135

Gs = 2.75
eo = 0.761
0.42eo = 0.320

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
26.4	395.8	97.4	0.761		95.3
27.9	395.8	98.2	0.747	0.10	100.0
27.9	395.8	98.6	0.740	0.25	100.0
27.9	395.8	99.1	0.732	0.50	100.0
27.9	395.8	99.7	0.722	1.00	100.0
27.9	395.8	100.6	0.706	2.00	100.0
27.9	395.8	101.8	0.686	4.00	100.0
27.9	395.8	103.7	0.655	8.00	100.0
7.9	395.8	102.6	0.672	2.00	100.0
27.9	395.8	101.3	0.694	0.50	100.0
27.9	395.8	100.1	0.715	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.744
2	0.726
3	0.708
4	0.691
5	0.673
6	0.655
7	0.638
8	0.620
9	0.603



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

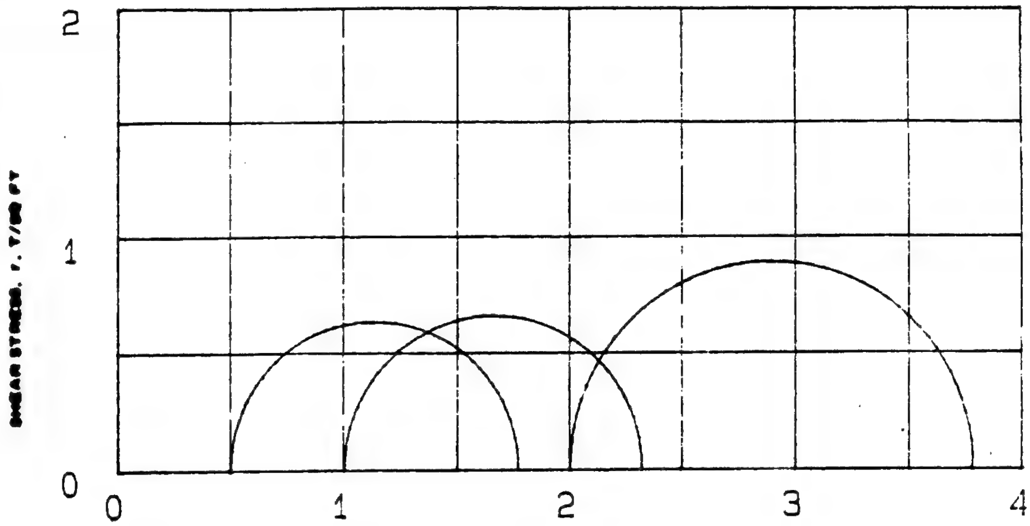
LL = 46	PL = 17	PI = 29	Gs = 2.75	NAT w = %

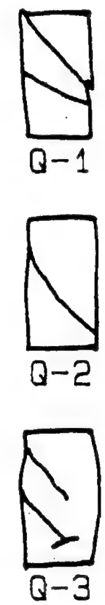
CLASSIFICATION

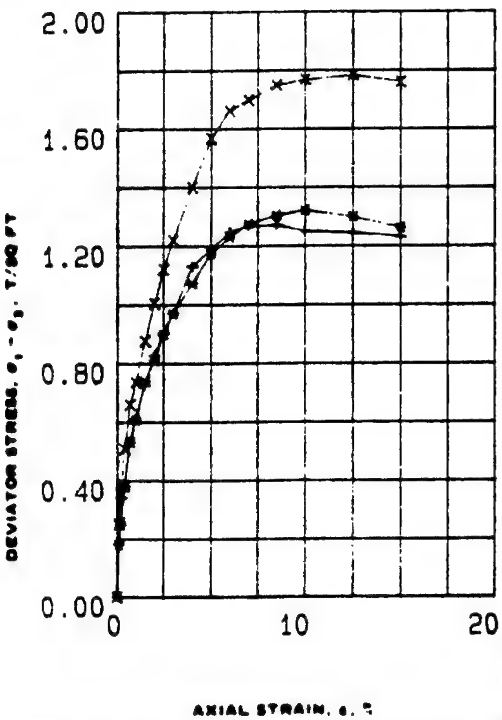
GRADATION CURVE

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-112 MU
SAMPLE NO.	S-4
DEPTH/ELEV	30'-32'
MRD LAB NO.	90/135

FIGURE 8







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	28.3	27.4	26.6	
	DRY DENSITY LB/CU FT	γ_{d_o}	96.1	97.5	99.0	
	SATURATION, %	S_o	99.0	99.0	100.0	
	VOID RATIO	e_o	0.79	0.76	0.73	
BEFORE SHEAR	WATER CONTENT, %	w_c	28.2	27.3	26.5	
	DRY DENSITY LB/CU FT	γ_{d_c}	96.1	97.5	99.0	
	SATURATION, %	S_c	99.0	98.0	99.0	
	VOID RATIO	e_c	0.79	0.76	0.73	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.27	1.32	1.78	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	18.5	21.5	27.5	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.23	1.26	1.76	
INITIAL DIAMETER, IN.		D_o	1.42	1.42	1.42	
INITIAL HEIGHT, IN.		H_o	2.98	2.98	2.99	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL

LL 46	PL 17	PI 29	G_s 2.75	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Medium gray. Torvane=1.2TSF
Slightly calcareous.

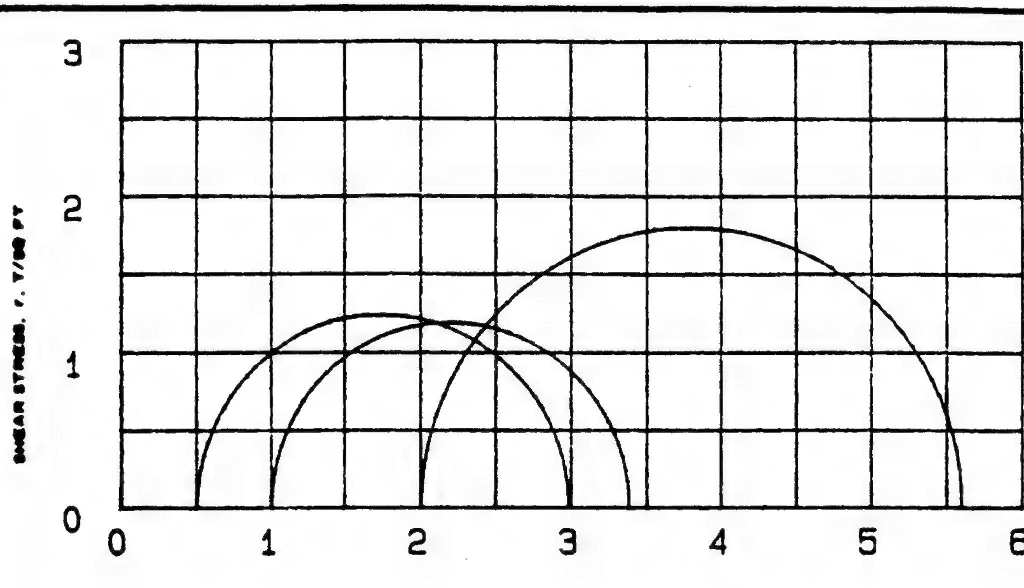
PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

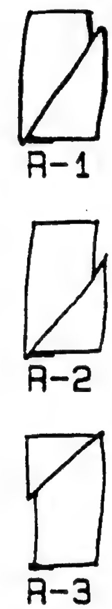
BORING NO 89-112 MU | SAMPLE NO. S-4

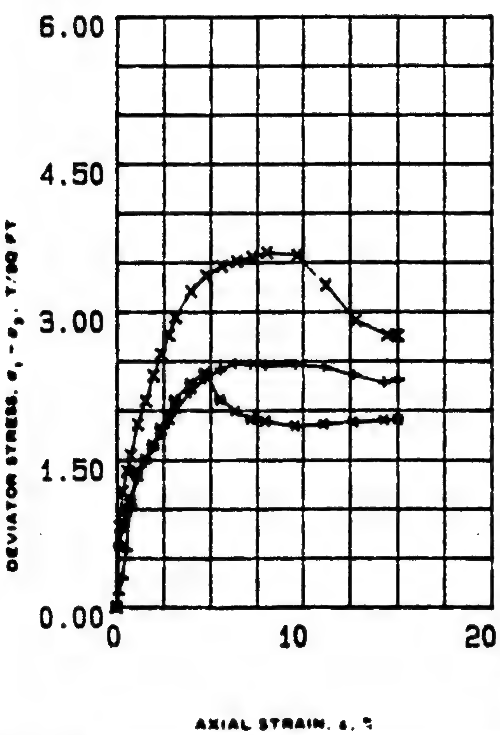
DEPTH ELEV 30'-32'

LABORATORY 90/135 | DATE

TRIAXIAL COMPRESSION TEST REPORT







			1 (+)	2 (*)	3 (X)	
SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	24.8	26.8	27.3	
	DRY DENSITY LB/CU FT	γ_{d_o}	99.8	97.7	97.1	
	SATURATION, %	S_o	95	97	98	
	VOID RATIO	e_o	.72	.76	.77	
BEFORE SHEAR	WATER CONTENT, %	w_c	26.2	27.9	27.2	
	DRY DENSITY LB/CU FT	γ_{d_c}	100.9	99.6	101.9	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.7	.73	.68	
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.543	5.543	5.543	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	2.477	2.381	3.597	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	480	360	600	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	2.304	1.906	2.753	
INITIAL DIAMETER, IN.		D_o	1.39	1.38	1.39	
INITIAL HEIGHT, IN.		H_o	2.99	3	3	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL B-Value 1.0 1.0 1.0

LL 46	PL 17	PI 29	Gs 2.75	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Medium gray. Torvane=1.25TSF
Slightly calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-BH

BORING NO 89-112 MU SAMPLE NO. S-4

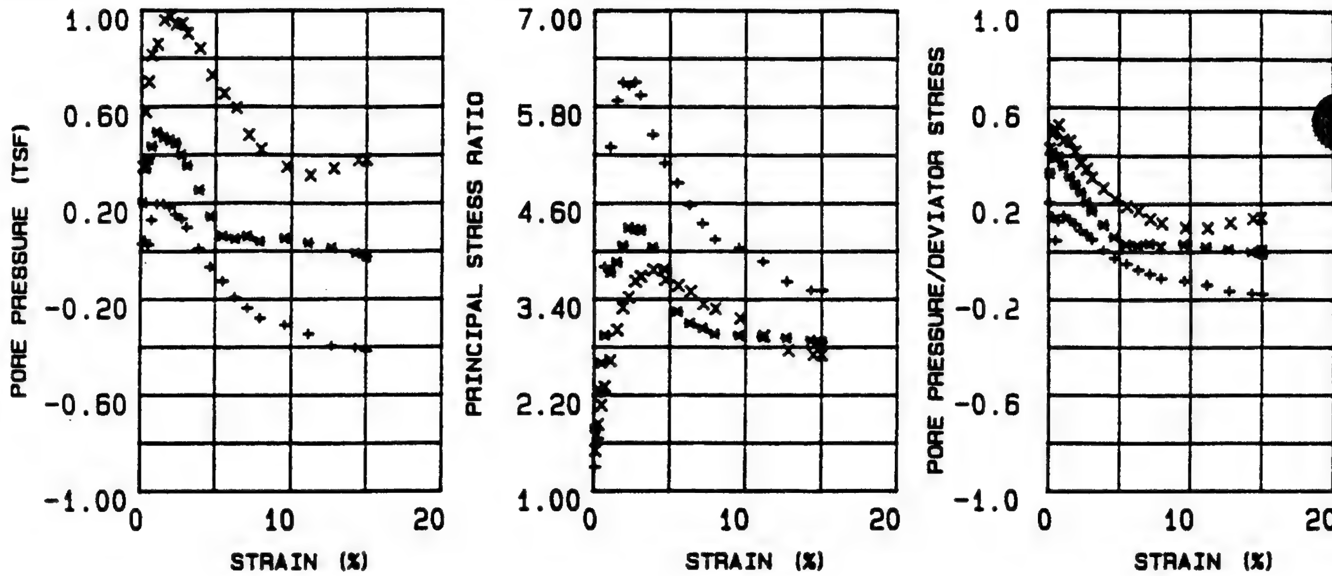
DEPTH ELEV 30'-32'

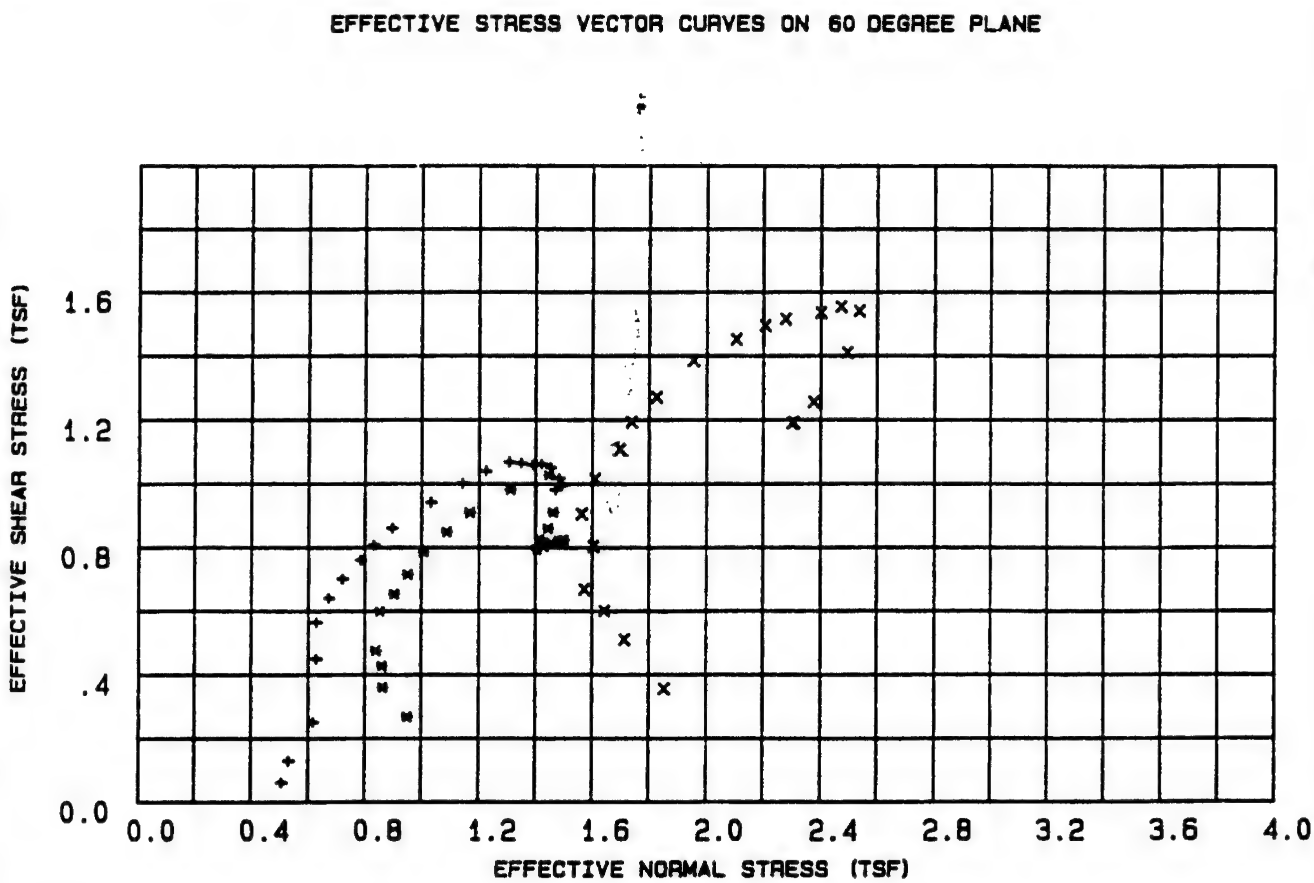
LABORATORY 90/135 DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 6





LEGEND

+ = .5 TSF

✱ = 1 TSF

X = 2 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-112 MU
SAMPLE NO.	S-4
DEPTH/ELEV	30'-32'
MRD LAB NO.	90/135

FIGURE 7

R

R

Table 1 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-112 MU
Sample Number : S-4
Depth : 30'-32'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.138	0.028	1.292	0.203	0.506	0.060
30	0.32	0.297	0.043	1.650	0.145	0.531	0.128
45	0.53	0.580	0.026	2.222	0.045	0.617	0.250
60	0.73	1.040	0.129	3.802	0.125	0.628	0.449
90	1.10	1.307	0.196	5.294	0.150	0.628	0.564
120	1.54	1.483	0.196	5.871	0.132	0.671	0.640
150	1.92	1.623	0.182	6.097	0.112	0.720	0.701
180	2.31	1.762	0.151	6.056	0.086	0.785	0.761
210	2.73	1.873	0.133	6.106	0.072	0.831	0.808
240	3.09	1.993	0.097	5.941	0.049	0.896	0.860
[illegible]	3.89	2.184	0.009	5.445	0.004	1.032	0.943
[illegible]	4.67	2.322	-0.068	5.091	-0.029	1.143	1.002
420	5.50	2.413	-0.128	4.843	-0.052	1.225	1.041
[illegible]	6.31	2.477	-0.194	4.567	-0.078	1.307	1.069
540	7.13	2.465	-0.239	4.337	-0.096	1.349	1.064
600	7.94	2.452	-0.281	4.138	-0.114	1.388	1.058
720	9.57	2.459	-0.311	4.034	-0.126	1.420	1.061
840	11.13	2.434	-0.349	3.866	-0.143	1.452	1.050
960	12.68	2.353	-0.400	3.615	-0.169	1.483	1.016
1080	14.29	2.271	-0.407	3.504	-0.179	1.469	0.980
1129	15.00	2.304	-0.420	3.505	-0.182	1.490	0.995
1129	15.00	2.304	-0.420	3.505	-0.182	1.490	0.995

Table 2 - Triaxial $\bar{R}$ Test Results

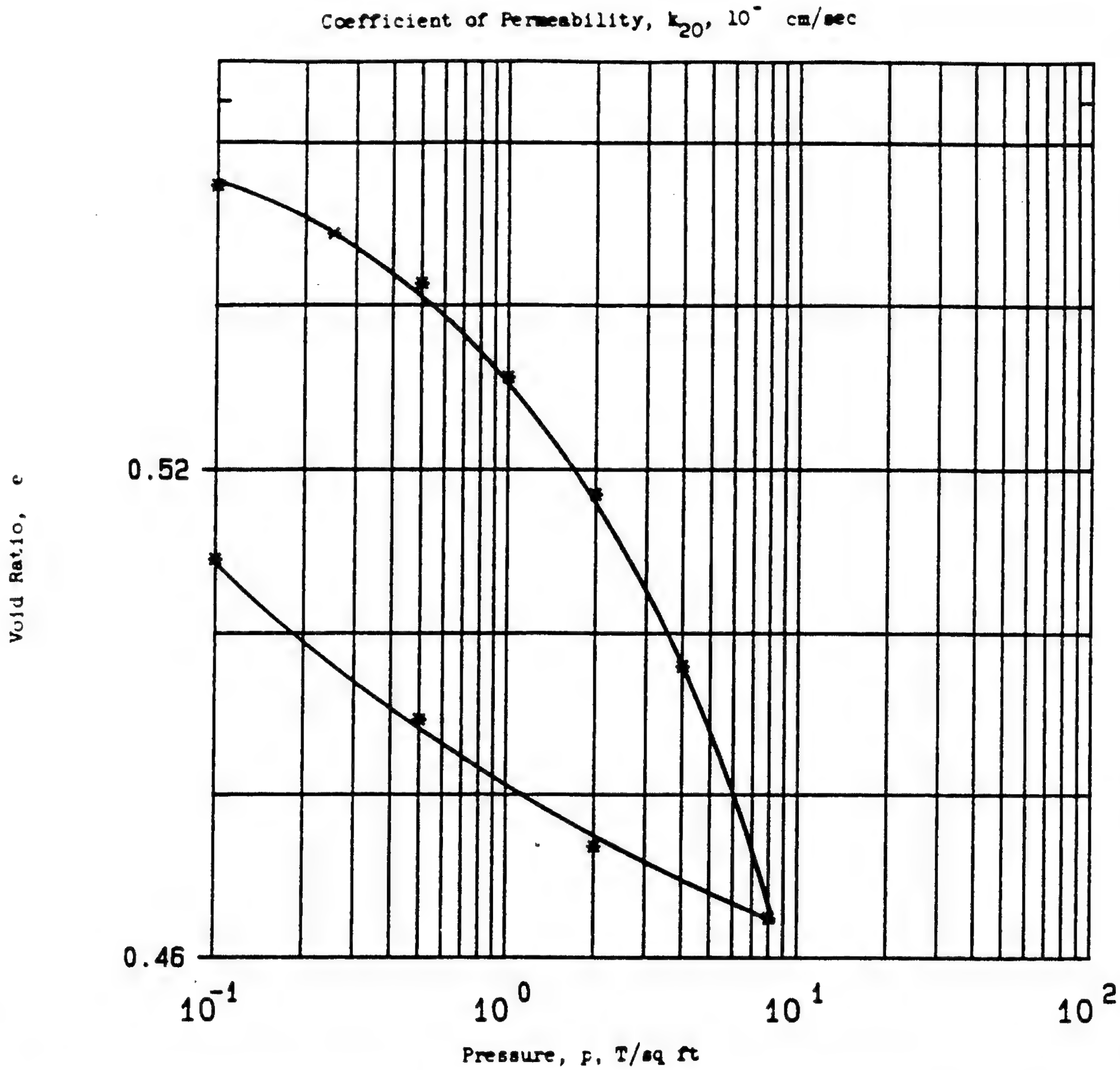
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-112 MU
Sample Number : S-4
Depth : 30'-32'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.619	0.202	1.776	0.326	0.951	0.267
30	0.32	0.833	0.343	2.269	0.412	0.863	0.360
45	0.53	0.987	0.383	2.600	0.389	0.861	0.426
60	0.73	1.101	0.434	2.945	0.394	0.839	0.475
90	1.09	1.388	0.492	3.734	0.355	0.852	0.599
120	1.53	1.514	0.471	3.861	0.311	0.904	0.653
150	1.92	1.660	0.459	4.065	0.277	0.952	0.716
180	2.31	1.824	0.446	4.293	0.245	1.006	0.787
210	2.72	1.966	0.399	4.269	0.203	1.088	0.849
240	3.08	2.109	0.354	4.264	0.168	1.168	0.910
300	3.89	2.274	0.252	4.042	0.111	1.311	0.982
360	4.66	2.381	0.142	3.773	0.060	1.447	1.028
420	5.49	2.109	0.060	3.244	0.029	1.462	0.910
480	6.29	1.991	0.049	3.094	0.025	1.444	0.85[illegible]
540	7.12	1.910	0.060	3.032	0.032	1.413	0.82[illegible]
[illegible]	7.92	1.886	0.037	2.959	0.020	1.430	0.814
720	9.55	1.837	0.052	2.939	0.029	1.403	0.793
840	11.10	1.861	0.031	2.920	0.017	1.430	0.803
960	12.66	1.883	0.012	2.906	0.007	1.454	0.813
1080	14.26	1.901	-0.011	2.880	-0.005	1.482	0.820
1131	15.00	1.906	-0.026	2.858	-0.013	1.498	0.822
1131	15.00	1.906	-0.026	2.858	0.000	1.498	0.822

Table 3 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-112 MU
Sample Number : S-4
Depth : 30'-32'
Confining Pressure : 2 TSF

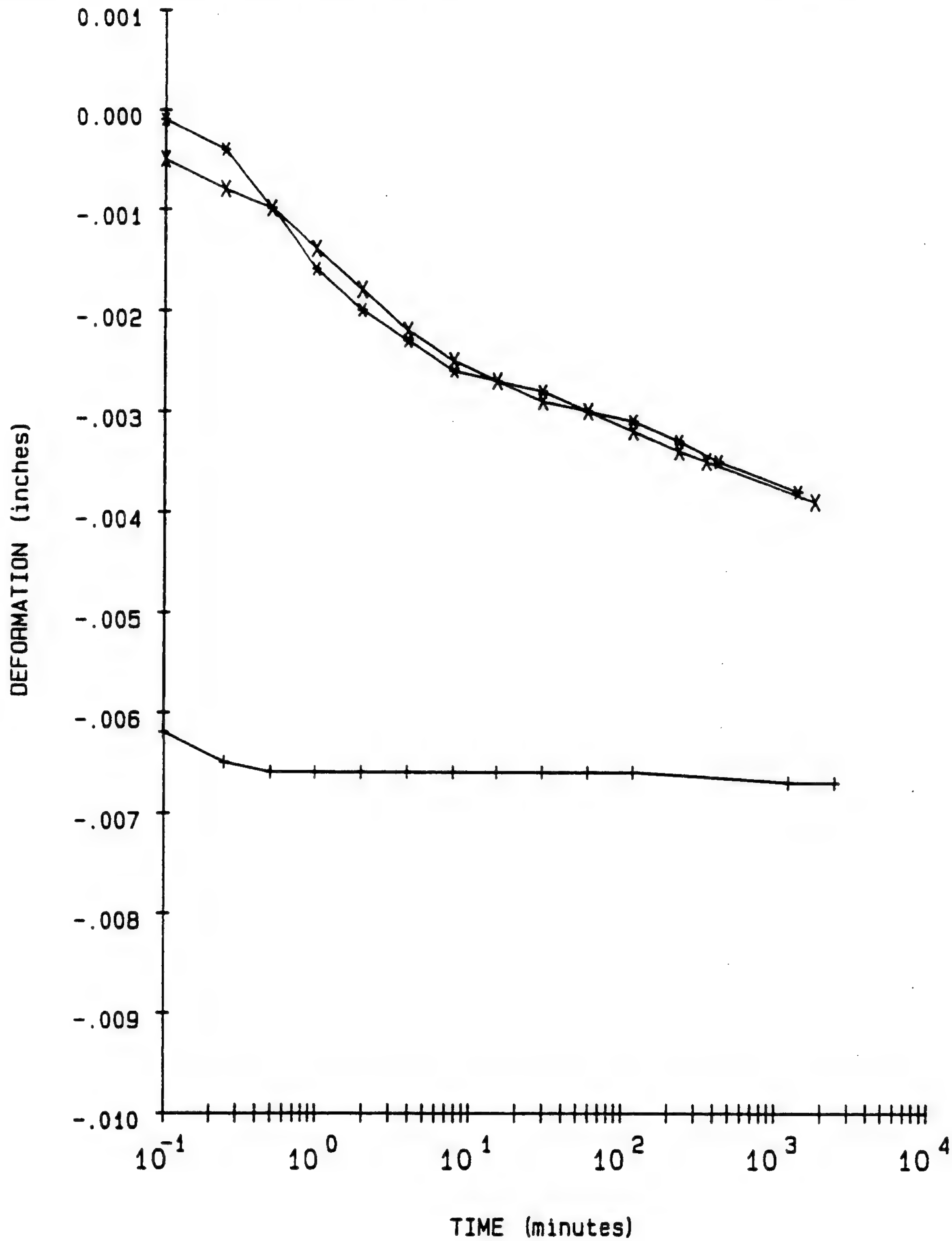
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.822	0.350	1.498	0.427	1.853	0.355
30	0.32	1.179	0.578	1.829	0.490	1.714	0.509
45	0.54	1.390	0.702	2.071	0.505	1.642	0.600
60	0.74	1.547	0.812	2.302	0.525	1.571	0.668
90	1.11	1.860	0.858	2.629	0.462	1.603	0.803
120	1.55	2.097	0.958	3.012	0.457	1.561	0.905
150	1.94	2.351	0.973	3.289	0.414	1.609	1.015
180	2.33	2.568	0.939	3.421	0.366	1.697	1.108
210	2.75	2.764	0.946	3.623	0.343	1.738	1.193
240	3.12	2.943	0.903	3.683	0.307	1.826	1.270
300	3.93	3.206	0.840	3.764	0.262	1.954	1.384
360	4.72	3.362	0.727	3.641	0.217	2.105	1.451
420	5.56	3.461	0.651	3.565	0.188	2.206	1.494
480	6.37	3.509	0.593	3.493	0.169	2.276	1.514
540	7.20	3.553	0.480	3.337	0.135	2.400	1.534
[illegible]	8.01	3.597	0.420	3.277	0.117	2.471	1.553
720	9.66	3.566	0.347	3.157	0.098	2.536	1.539
840	11.23	3.263	0.314	2.935	0.097	2.494	1.408
960	12.81	2.906	0.344	2.754	0.119	2.375	1.254
1080	14.43	2.758	0.377	2.699	0.137	2.306	1.190
1119	15.00	2.753	0.381	2.701	0.139	2.300	1.188
1119	15.00	2.753	0.381	2.701	0.000	2.300	1.188



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.3 in.	Ht 1 in.	Water Content, w_o	24.8 %	w_f	24.2 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	0.57	e_f	0.51
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	100 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	108.8 lb/ft^3		
Classification Lean clay, CL		k_{20} at e_o = × 10^{-} cm/sec			
LL 38	G_s 2.73	Project	MINNESOTA RIVER; IA-90-04-ED-GH		
PL 17	D_{10}				
Remarks Medium gray. Torvane=0.85		Area	MRD LAB NO. 90/135		
TSF. Calcareous.		Boring No.	89-112MU	Sample No.	S-5
		Depth El	42.0'-44.0	Date	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE

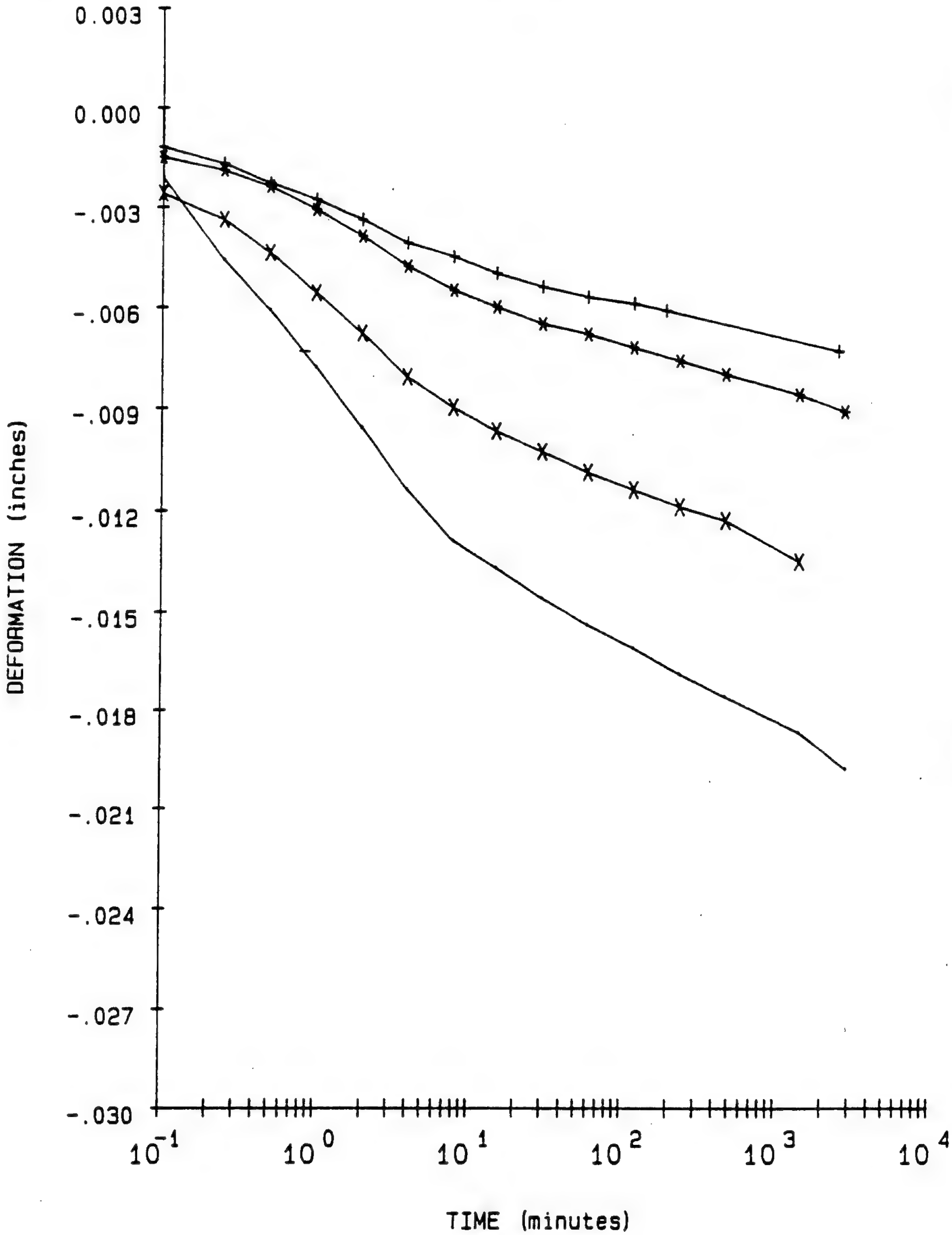
Figure 9



LEGEND	
+ =	.1 TSF
* =	.25 TSF
X =	.5 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-112MU
SAMPLE NO.	S-5
DEPTH/ELEV	42.0'-44.0'
MRD LAB NO.	90/135

FIGURE 10

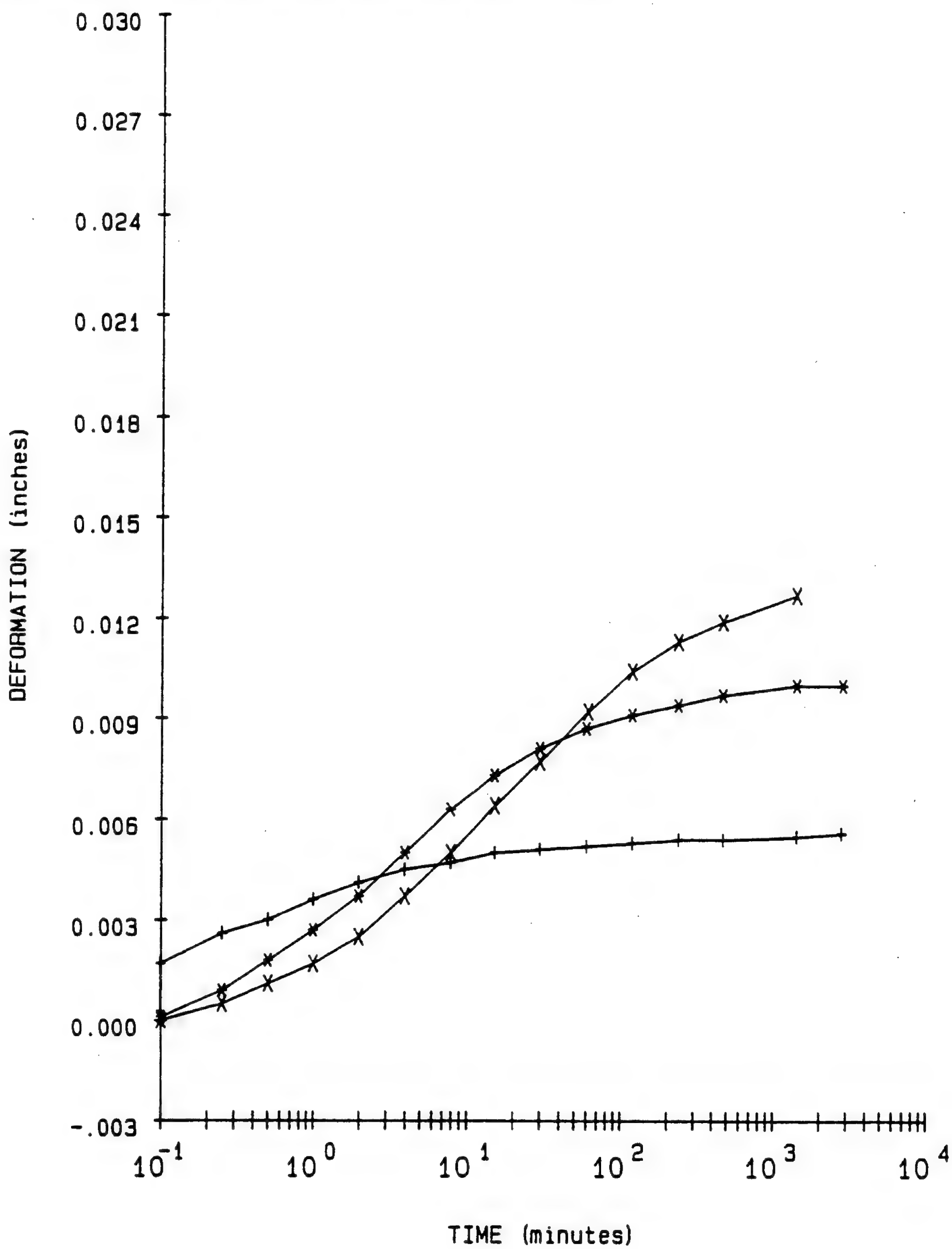


LEGEND

+ =	1	TSF
* =	2	TSF
X =	4	TSF
- =	8	TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-112MU
SAMPLE NO.	S-5
DEPTH/ELEV	42.0'-44.0'
MRD LAB NO.	90/135

FIGURE 11



LEGEND		
+ = 2	TSF	Rebound
* = .5	TSF	Rebound
X = .1	TSF	Rebound

PROJECT	MINNESOTA RIVER; 1--90-04-ED-GH
BORING NO.	89-112MU
SAMPLE NO.	S-5
DEPTH/ELEV	42.0'-44.0'
MRD LAB NO.	90/135

FIGURE 12

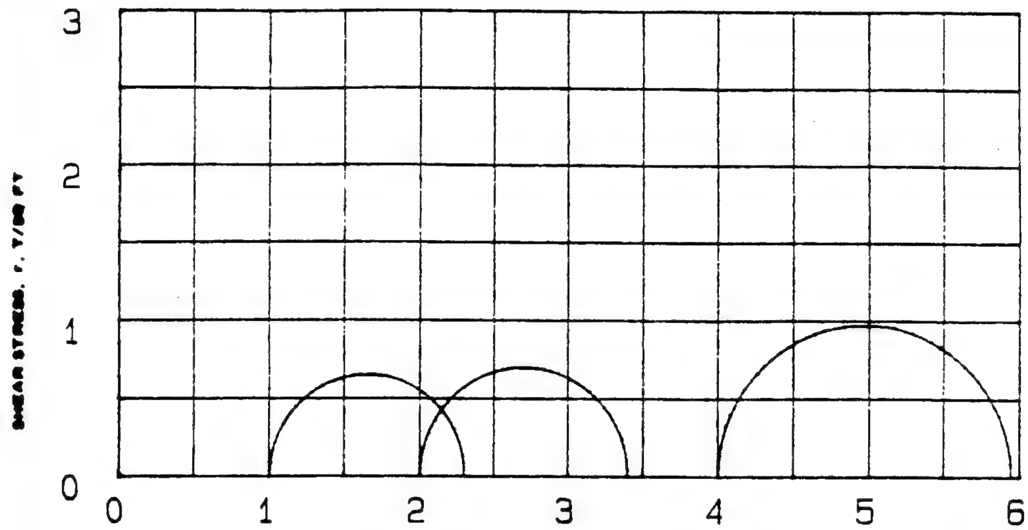
Consolidation Test Data

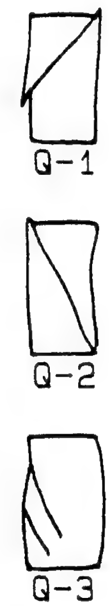
Project	MINNESOTA RIVER; IA-90-04-ED-GH
Boring No.	89-112MU
Sample No.	S-5
Depth/Elev	42.0'-44.0'
MRD Lab No.	90/135

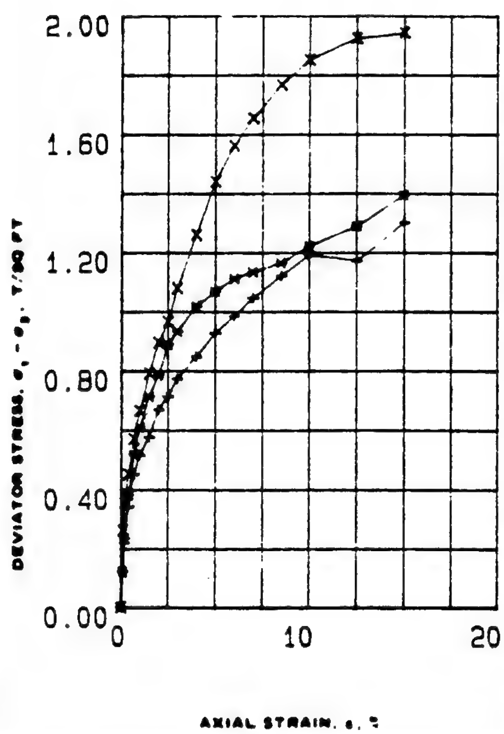
Gs = 2.73
eo = 0.565
0.42eo = 0.237

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
24.8	412.0	108.8	0.565		100.0
24.2	412.0	109.6	0.555	0.10	100.0
24.2	412.0	110.0	0.549	0.25	100.0
24.2	412.0	110.4	0.543	0.50	100.0
24.2	412.0	111.3	0.531	1.00	100.0
24.2	412.0	112.3	0.517	2.00	100.0
24.2	412.0	113.9	0.496	4.00	100.0
24.2	412.0	116.3	0.465	8.00	100.0
24.2	412.0	115.6	0.474	2.00	100.0
24.2	412.0	114.4	0.489	0.50	100.0
24.2	412.0	112.9	0.509	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.549
2	0.534
3	0.518
4	0.503
5	0.487
6	0.471
7	0.456
8	0.440
9	0.424







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	25.4	24.1	24.2	
	DRY DENSITY LB/CU FT	γ_{d_o}	101.3	103.1	103.0	
	SATURATION, %	S_o	100.0	100.0	100.0	
	VOID RATIO	e_o	0.68	0.65	0.65	
BEFORE SHEAR	WATER CONTENT, %	w_c	25.4	24.0	24.0	
	DRY DENSITY LB/CU FT	γ_{d_c}	101.3	103.1	103.2	
	SATURATION, %	S_c	100.0	100.0	100.0	
	VOID RATIO	e_c	0.68	0.65	0.65	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.0	2.0	4.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.30	1.40	1.94	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	31.8	31.8	31.5	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.30	1.40	1.94	
INITIAL DIAMETER, IN.		D_o	1.42	1.42	1.42	
INITIAL HEIGHT, IN.		H_o	2.98	2.98	3.00	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL

LL 38 | PL 17 | PI 21 | G_s 2.73 | TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST Q

REMARKS: Medium gray. Torvane=0.85TSF. Calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

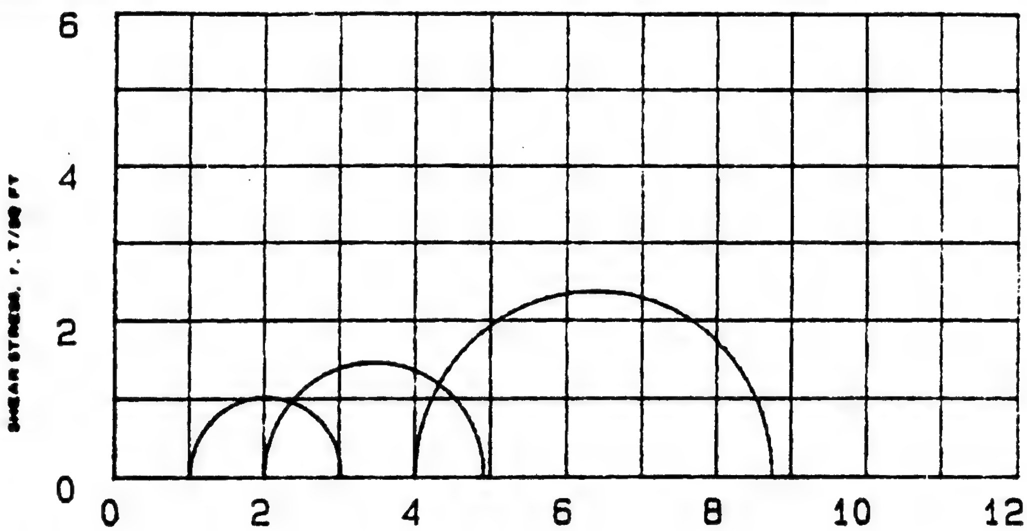
BORING NO 89-112MU | SAMPLE NO. S-5

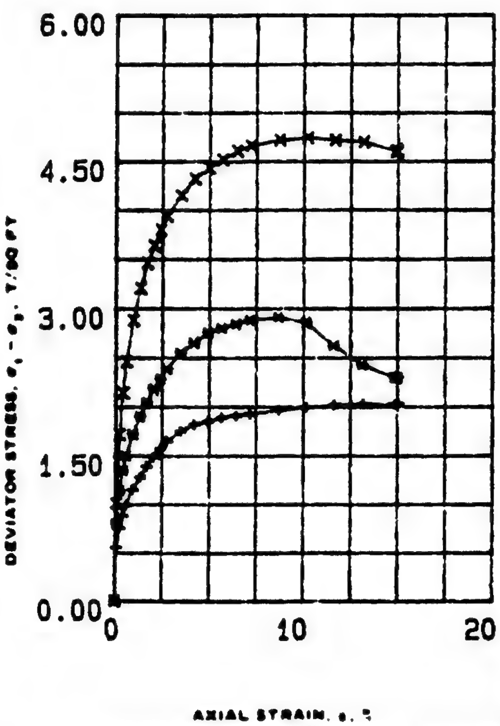
DEPTH ELEV 42'-44'

LABORATORY 90/135 | DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 13





SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	25.1	25.6	24.4	
	DRY DENSITY LB/CU FT	γ_{d_o}	101.3	99.7	101.9	
	SATURATION, %	S_o	100	98	99	
	VOID RATIO	e_o	.66	.71	.67	
BEFORE SHEAR	WATER CONTENT, %	w_c	25.1	27	24.3	
	DRY DENSITY LB/CU FT	γ_{d_c}	102.7	102.4	105.9	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.66	.67	.61	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1	2	4	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	2.024	2.911	4.742	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1080	720	840	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	2.023	2.293	4.598	
INITIAL DIAMETER, IN.		D_o	1.39	1.4	1.39	
INITIAL HEIGHT, IN.		H_o	2.96	2.98	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL B-Value 1.0 1.0 1.0

LL	PL	PI	G_s
38	17	21	2.73

TYPE OF SPECIMEN UNDISTURBED TYPE OF TEST RBAR

REMARKS Medium gray. Torvane=0.85TSF. Calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-BH

BORING NO 89-112 MU SAMPLE NO. S-5

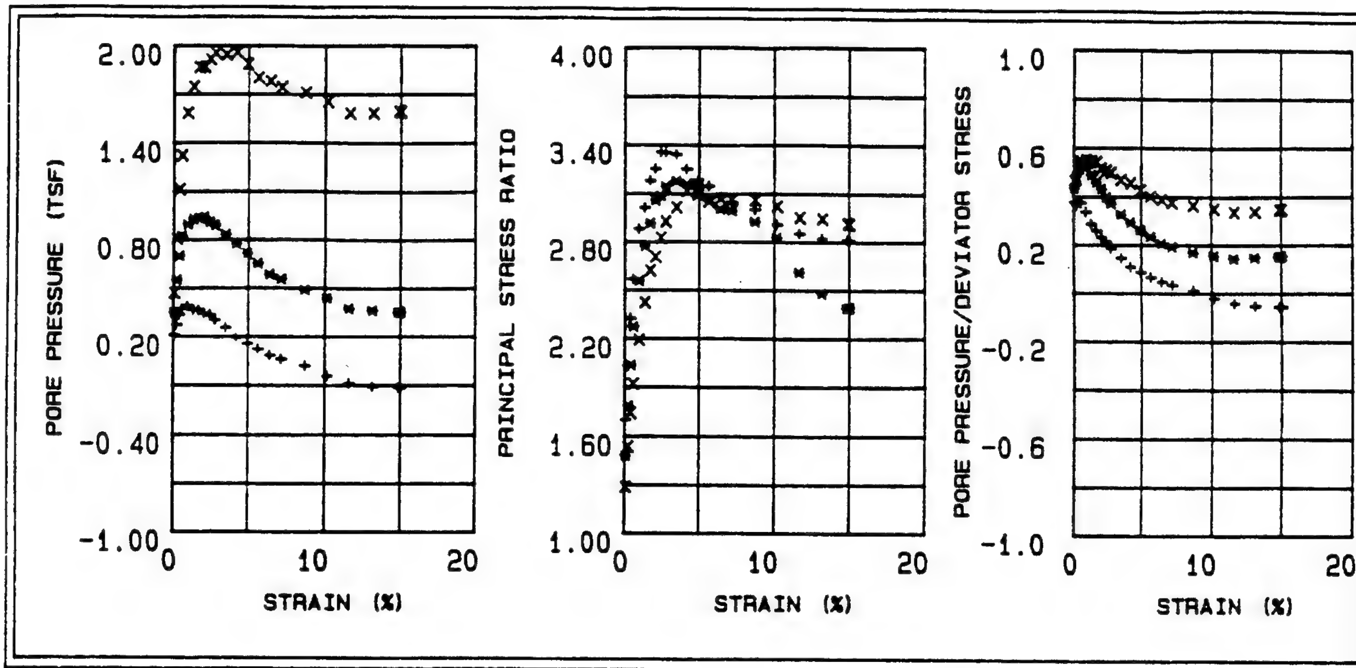
DEPTH ELEV 42'-44'

LABORATORY 90/135 DATE

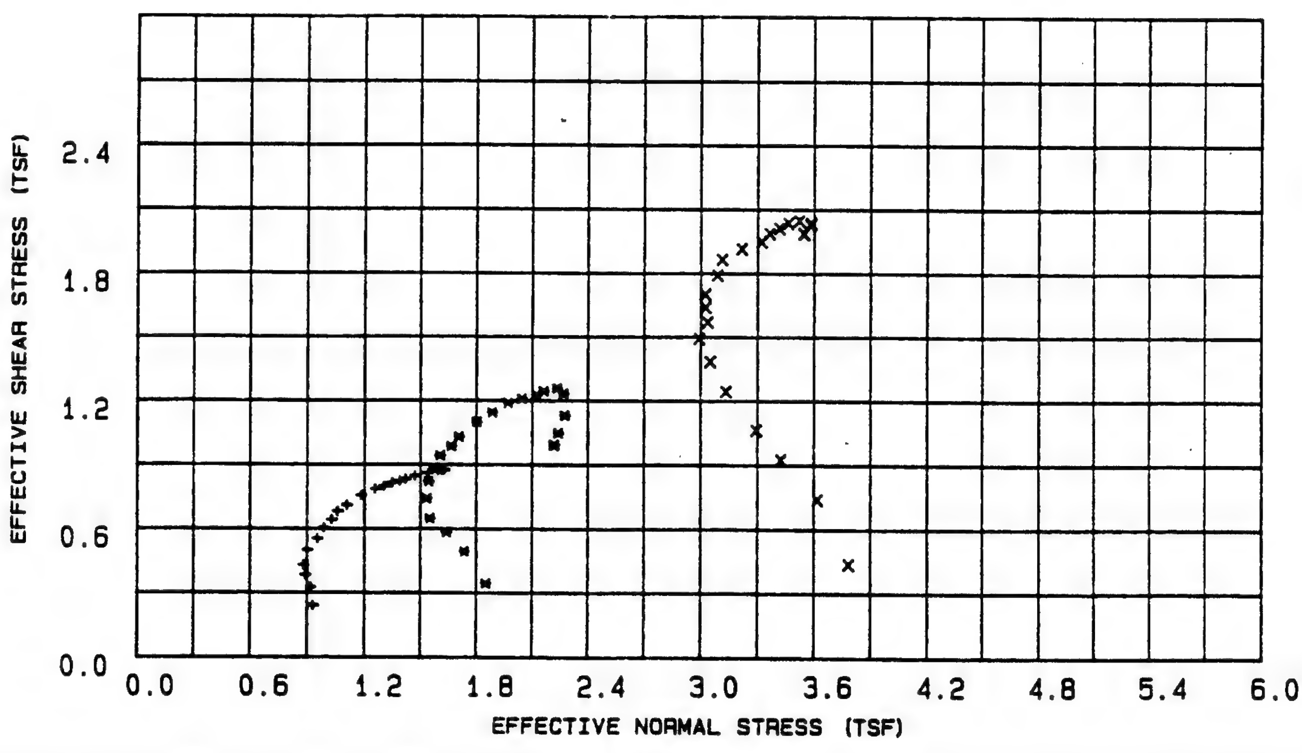
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 14



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = 1 TSF

✱ = 2 TSF

X = 4 TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-112 MU
SAMPLE NO.	S-5
DEPTH/ELEV	42'-44'
MRD LAB NO.	90/135

FIGURE 15

R

Table 4 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-112 MU
Sample Number : S-5
Depth : 42'-44'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.553	0.207	1.698	0.375	0.930	0.239
30	0.24	0.750	0.270	2.028	0.361	0.916	0.324
45	0.41	0.883	0.332	2.323	0.377	0.887	0.381
60	0.58	0.989	0.368	2.565	0.373	0.877	0.427
90	0.94	1.153	0.386	2.877	0.335	0.899	0.498
120	1.33	1.279	0.364	3.010	0.285	0.953	0.552
150	1.69	1.396	0.359	3.177	0.257	0.987	0.603
180	2.05	1.486	0.340	3.251	0.229	1.028	0.641
210	2.42	1.575	0.331	3.355	0.211	1.059	0.680
240	2.76	1.646	0.300	3.352	0.183	1.107	0.710
300	3.48	1.750	0.252	3.339	0.144	1.181	0.755
360	4.18	1.818	0.192	3.250	0.106	1.258	0.784
[illegible]	4.93	1.848	0.154	3.184	0.084	1.304	0.798
[illegible]	5.66	1.887	0.120	3.146	0.064	1.347	0.815
540	6.43	1.907	0.083	3.080	0.044	1.389	0.823
600	7.18	1.927	0.058	3.046	0.031	1.419	0.832
720	8.71	1.964	0.017	2.999	0.009	1.469	0.848
840	10.16	1.993	-0.047	2.903	-0.023	1.540	0.860
960	11.63	2.018	-0.092	2.848	-0.045	1.592	0.871
1080	13.16	2.024	-0.113	2.819	-0.055	1.614	0.874
1200	14.85	2.022	-0.118	2.809	-0.058	1.619	0.873
1211	15.00	2.023	-0.121	2.805	-0.059	1.622	0.873
1211	15.00	2.023	-0.121	2.805	-0.059	1.622	0.873

Table 5 - Triaxial $\bar{R}$ Test Results

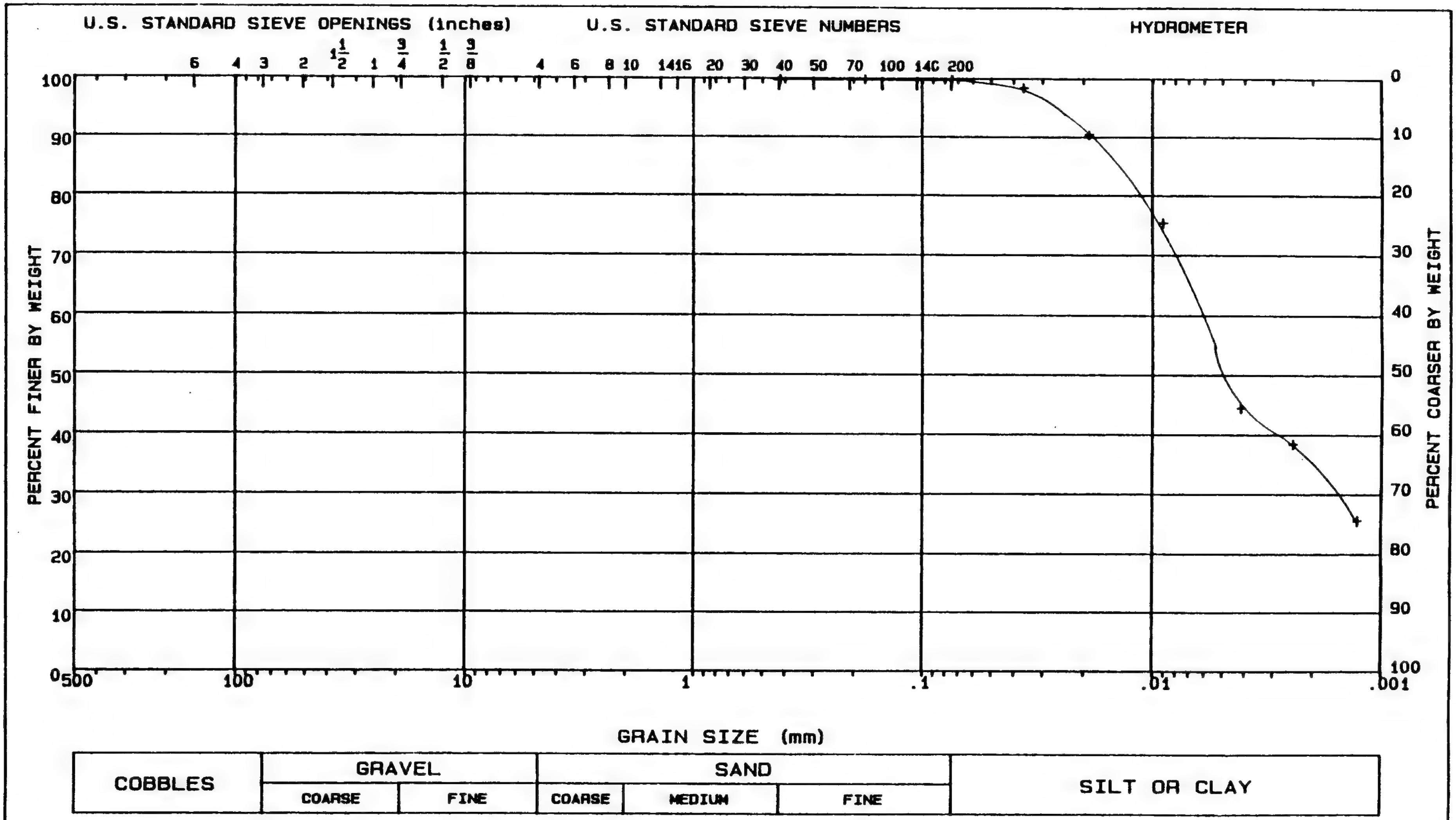
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-112 MU
Sample Number : S-5
Depth : 42'-44'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.795	0.345	1.480	0.434	1.852	0.343
30	0.24	1.140	0.548	1.785	0.482	1.734	0.492
45	0.41	1.348	0.698	2.035	0.518	1.636	0.582
60	0.58	1.499	0.821	2.271	0.549	1.550	0.647
90	0.94	1.720	0.893	2.554	0.520	1.533	0.742
120	1.33	1.901	0.927	2.771	0.488	1.544	0.820
150	1.69	2.043	0.933	2.914	0.457	1.573	0.882
180	2.05	2.184	0.938	3.056	0.430	1.603	0.942
210	2.41	2.285	0.904	3.085	0.396	1.662	0.986
240	2.75	2.387	0.886	3.142	0.371	1.705	1.030
300	3.48	2.550	0.829	3.177	0.325	1.802	1.100
360	4.18	2.654	0.770	3.159	0.291	1.887	1.146
420	4.93	2.756	0.712	3.140	0.259	1.970	1.189
480	5.65	2.801	0.648	3.071	0.232	2.045	1.209
5[illegible]	6.42	2.843	0.580	3.002	0.204	2.124	1.227
[illegible]	7.17	2.885	0.551	2.991	0.191	2.163	1.245
720	8.69	2.911	0.485	2.922	0.167	2.236	1.257
840	10.14	2.851	0.436	2.822	0.153	2.270	1.231
960	11.61	2.619	0.371	2.608	0.142	2.277	1.130
1080	13.13	2.424	0.358	2.476	0.148	2.242	1.046
1200	14.82	2.294	0.346	2.387	0.151	2.222	0.990
1212	15.00	2.293	0.349	2.389	0.153	2.218	0.990
1212	15.00	2.293	0.349	2.389	0.153	2.218	0.990

Table 6 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-112 MU
Sample Number : S-5
Depth : 42'-44'
Confining Pressure : 4 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	1.008	0.467	1.285	0.464	3.783	0.435
30	0.24	1.711	0.806	1.536	0.471	3.618	0.738
45	0.41	2.141	1.110	1.741	0.519	3.420	0.924
60	0.58	2.460	1.319	1.918	0.537	3.290	1.062
90	0.95	2.879	1.582	2.191	0.550	3.131	1.243
120	1.33	3.205	1.745	2.421	0.545	3.048	1.383
150	1.70	3.457	1.866	2.620	0.540	2.990	1.492
180	2.06	3.636	1.866	2.704	0.514	3.034	1.570
210	2.42	3.797	1.916	2.822	0.505	3.024	1.639
240	2.76	3.939	1.953	2.925	0.496	3.022	1.700
300	3.49	4.148	1.941	3.014	0.468	3.086	1.790
360	4.20	4.320	1.958	3.115	0.454	3.111	1.864
420	4.95	4.434	1.883	3.094	0.425	3.215	1.914
480	5.67	4.513	1.799	3.050	0.399	3.318	1.948
[illegible]	6.45	4.604	1.778	3.072	0.387	3.362	1.987
[illegible]	7.20	4.660	1.741	3.063	0.374	3.413	2.011
720	8.73	4.718	1.707	3.058	0.362	3.461	2.036
840	10.19	4.742	1.653	3.020	0.349	3.521	2.047
960	11.67	4.713	1.582	2.949	0.336	3.585	2.034
1080	13.19	4.695	1.582	2.942	0.337	3.580	2.027
1200	14.89	4.602	1.594	2.913	0.347	3.545	1.986
1208	15.00	4.598	1.592	2.909	0.347	3.546	1.984
1208	15.00	4.598	1.592	2.909	0.347	3.546	1.984



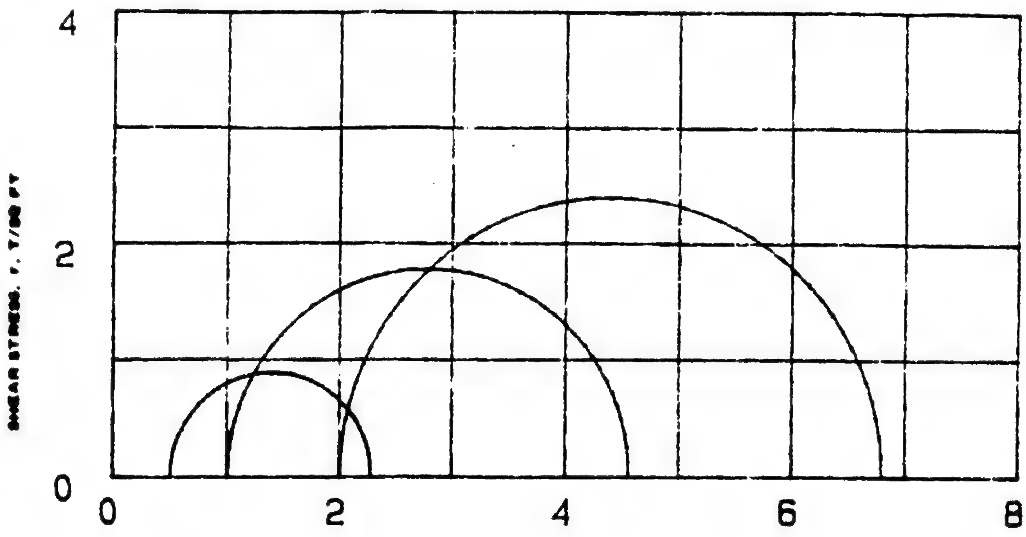
LL = 38	PL = 17	PI = 21	Gs = 2.73	NAT w = %

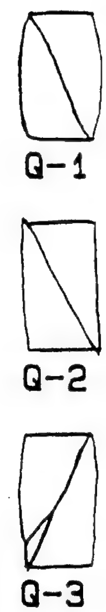
CLASSIFICATION Lean clay, CL

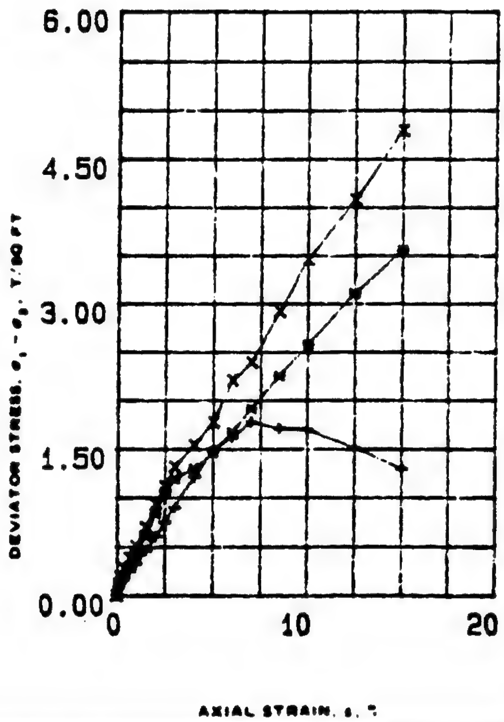
GRADATION CURVE

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-112 MU
SAMPLE NO.	S-5
DEPTH/ELEV	42'-44'
MRD LAB NO.	90/135

FIGURE 16







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	27.7	26.7	27.4	
	DRY DENSITY LB/CU FT	γ_{d_o}	97.2	98.6	97.7	
	SATURATION, %	S_o	100.0	100.0	100.0	
	VOID RATIO	e_o	0.74	0.70	0.73	
BEFORE SHEAR	WATER CONTENT, %	w_c	28.2	26.4	27.0	
	DRY DENSITY LB/CU FT	γ_{d_c}	97.2	98.6	97.7	
	SATURATION, %	S_c	100.0	100.0	100.0	
	VOID RATIO	e_c	0.74	0.70	0.73	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.78	3.56	4.79	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	15.0	31.3	32.0	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.29	3.56	4.79	
INITIAL DIAMETER, IN.		D_o	1.41	1.42	1.41	
INITIAL HEIGHT, IN.		H_o	2.99	2.94	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Silt, ML

LL 28	PL 22	PI 6	G_s 2.71	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Mottled Med. Brown and rust. Torvane=0.25 TSF. Calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-SH

~~[illegible]~~ OK

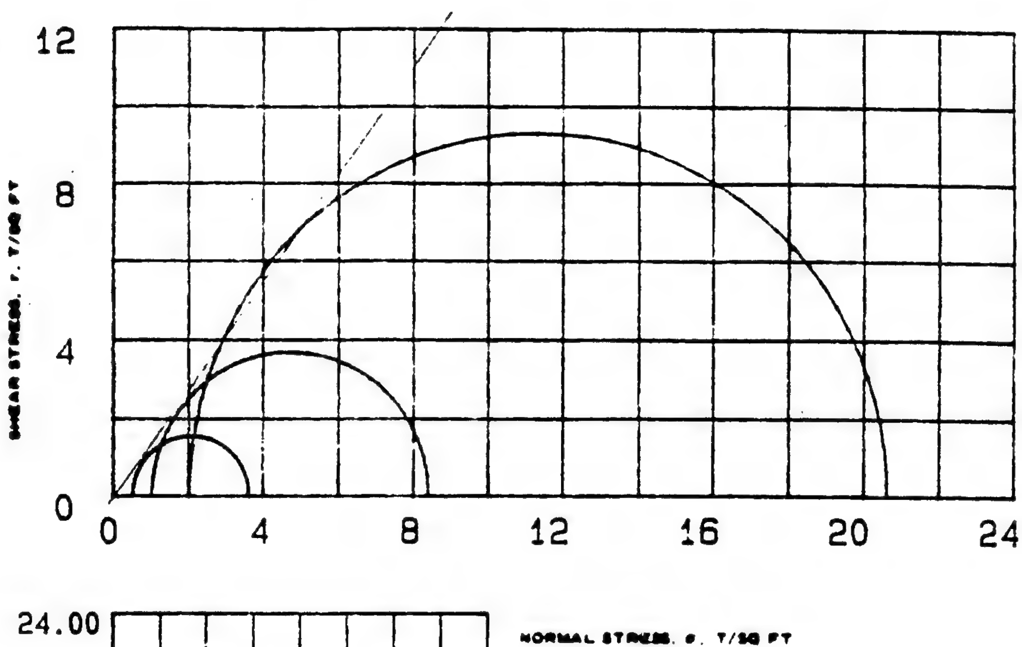
BORING NO. 90-147 MU SAMPLE NO. S-1

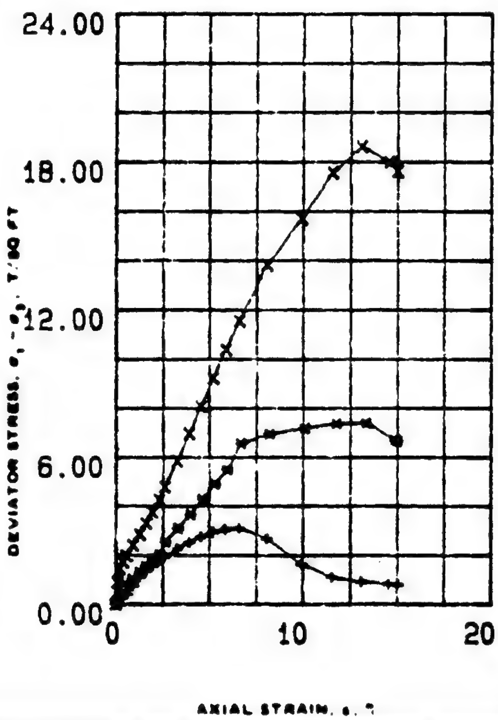
DEPTH ELEV 7'-9'

LABORATORY 90/136 DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 1





SPECIMEN NO			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	26.1	25.3	25.5	
	DRY DENSITY LB/CU FT	γ_{d_o}	100	102.5	101.4	
	SATURATION, %	S_o	100	100	100	
	VOID RATIO	e_o	.69	.65	.67	
BEFORE SHEAR	WATER CONTENT, %	w_c	28	25.3	25.8	
	DRY DENSITY LB/CU FT	γ_{d_c}	99.6	103.5	100.4	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.7	.63	.69	
	FINAL BACK PRESSURE, T/SQ FT	u_o	3.383	4.823	3.383	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	3.113	7.398	18.611	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	600	1080	1080	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.784	6.663	17.613	
INITIAL DIAMETER, IN.		D_o	1.38	1.39	1.38	
INITIAL HEIGHT, IN.		H_o	2.99	2.96	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Silt, ML B-Value 1.0 1.0 1.0

LL 28	PL 22	PI 6	G: 2.71	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Mottled med. brown and rust.
Torvane=0.25 TSF. Calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

BORING NO ~~89-117MU~~ SAMPLE NO. S-1

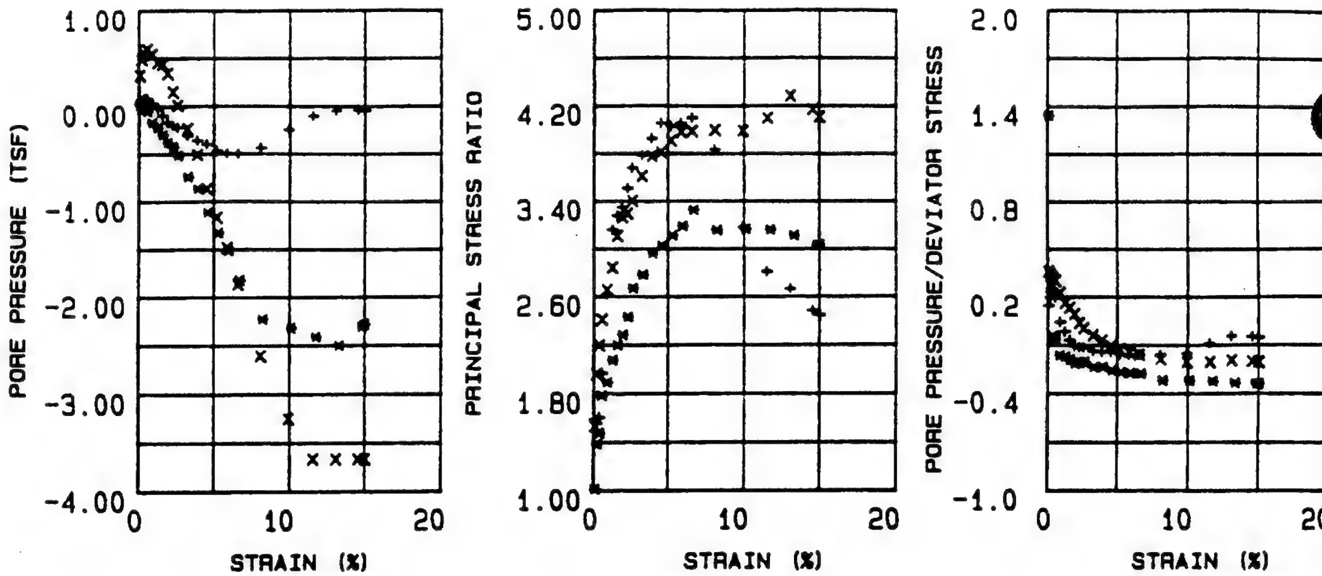
DEPTH ELEV 7.0'-9.0'

LABORATORY 90/135 DATE

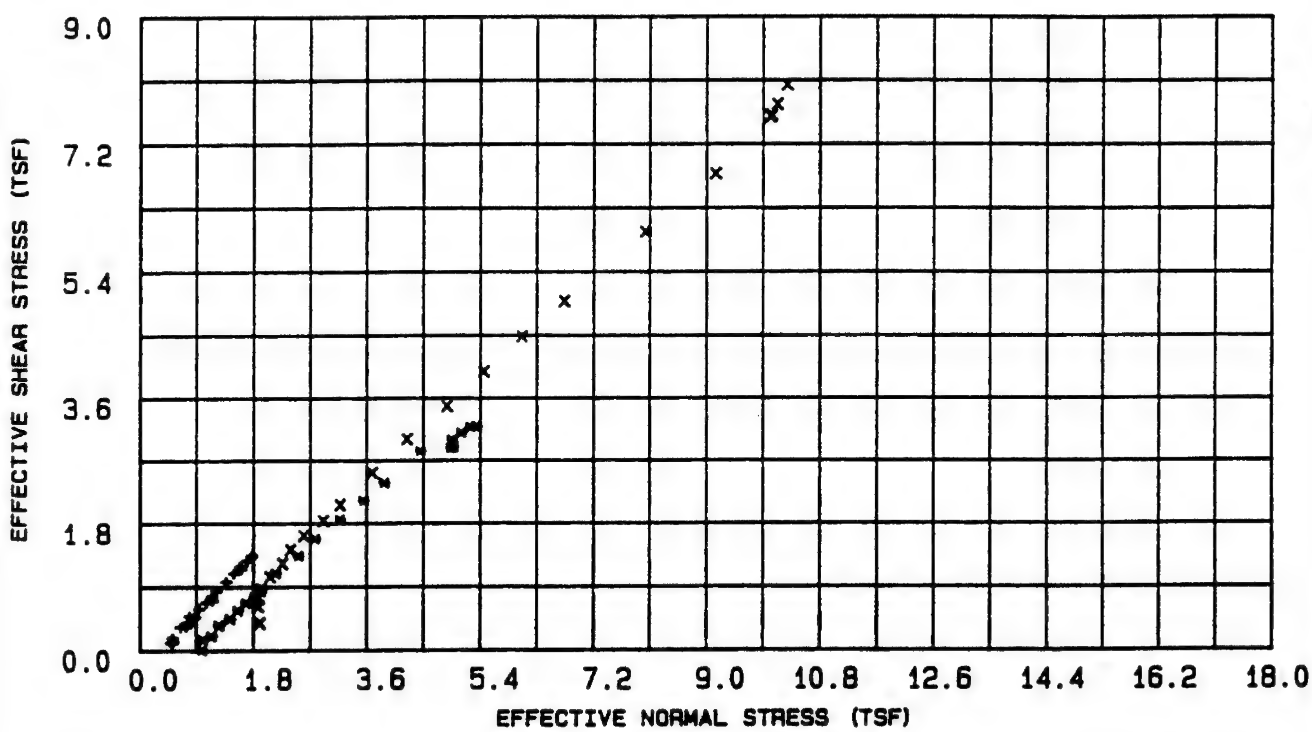
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 2



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF
* = 1 TSF
X = 2 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
	OF
BORING NO.	~~89-117MU~~
SAMPLE NO.	S-1
DEPTH/ELEV	7.0'-9.0'
MRD LAB NO.	90/135

R

Table 1 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : ~~89-117MU~~ [illegible] MU
Sample Number : S-1
Depth : 7.0'-9.0'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.09	0.271	0.039	1.587	0.146	0.528	0.117
30	0.21	0.251	0.049	1.557	0.198	0.513	0.108
45	0.38	0.258	0.073	1.604	0.283	0.491	0.111
60	0.57	0.408	0.079	1.968	0.193	0.522	0.176
90	0.90	0.761	0.031	2.621	0.041	0.657	0.328
120	1.26	1.120	-0.019	3.158	-0.016	0.796	0.483
150	1.59	1.361	-0.098	3.278	-0.071	0.935	0.587
180	1.92	1.574	-0.170	3.348	-0.108	1.060	0.679
210	2.28	1.767	-0.205	3.506	-0.116	1.143	0.763
240	2.58	1.943	-0.226	3.678	-0.116	1.207	0.839
300	3.25	2.255	-0.310	3.784	-0.137	1.368	0.973
360	3.89	2.528	-0.364	3.926	-0.143	1.490	1.091
420	4.53	2.754	-0.402	4.055	-0.145	1.584	1.189
4[illegible]	5.19	2.942	-0.472	4.028	-0.160	1.700	1.270
5[illegible]	5.85	3.051	-0.499	4.053	-0.163	1.754	1.317
600	6.57	3.113	-0.504	4.102	-0.161	1.775	1.343
720	8.06	2.666	-0.441	3.833	-0.165	1.601	1.151
840	9.91	1.626	-0.246	3.180	-0.151	1.149	0.702
960	11.52	1.085	-0.100	2.808	-0.092	0.869	0.468
1080	13.06	0.901	-0.042	2.662	-0.046	0.765	0.389
1200	14.53	0.801	-0.041	2.481	-0.050	0.739	0.346
1240	15.00	0.784	-0.044	2.442	-0.055	0.738	0.338

Figure C-401

Table 2 - Triaxial $\bar{R}$ Test Results

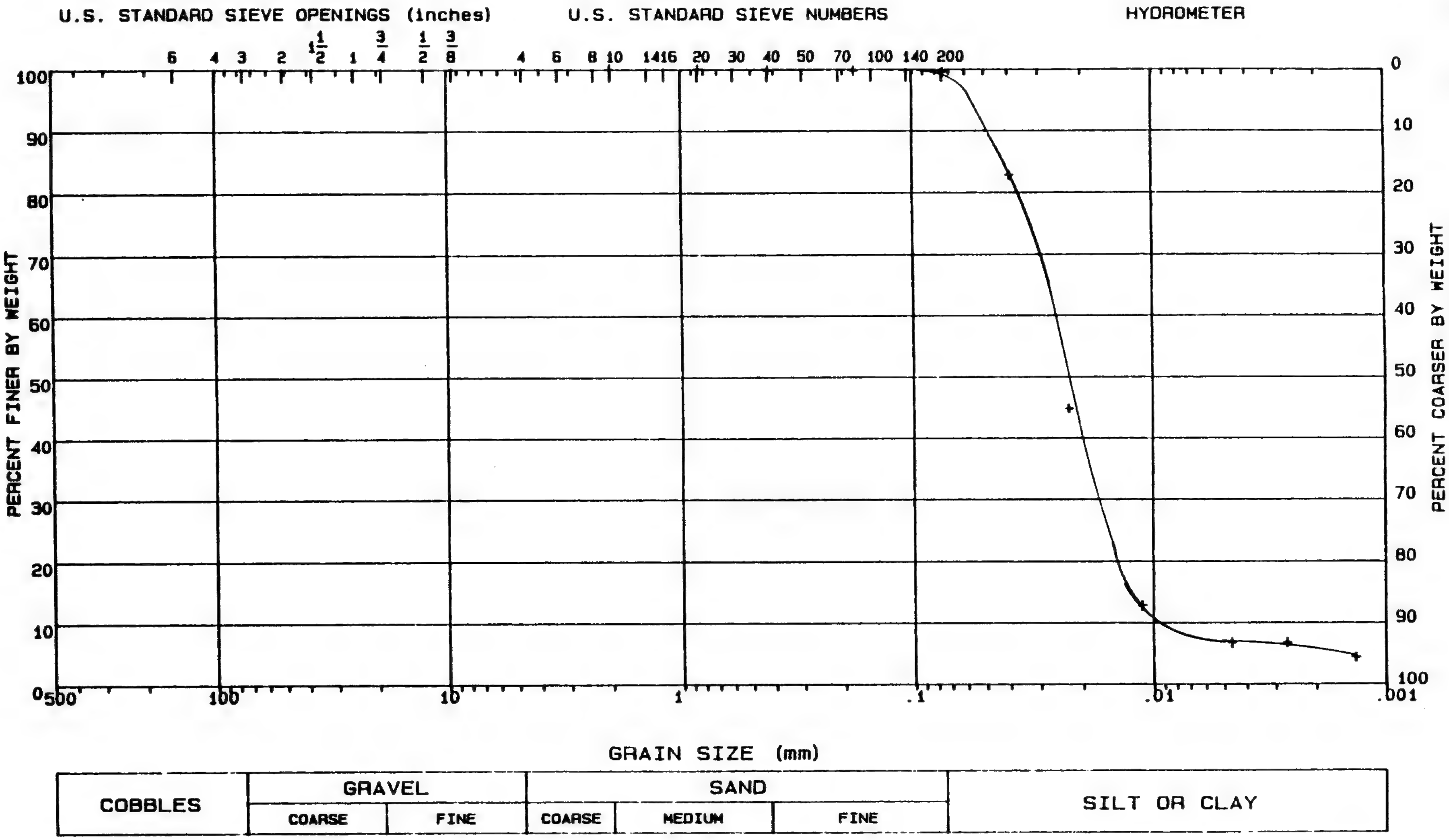
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : ~~89-117MU~~ [illegible]
Sample Number : S-1
Depth : 7.0'-9.0'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.010	0.014	1.011	1.343	0.989	0.004
30	0.22	0.353	0.081	1.384	0.229	1.006	0.152
45	0.39	0.484	-0.021	1.474	-0.043	1.141	0.209
60	0.58	0.824	-0.053	1.783	-0.064	1.257	0.356
90	0.92	1.045	-0.172	1.892	-0.164	1.431	0.451
120	1.28	1.321	-0.228	2.075	-0.172	1.555	0.570
150	1.62	1.559	-0.301	2.198	-0.192	1.687	0.673
180	1.96	1.774	-0.383	2.283	-0.215	1.822	0.766
210	2.32	2.045	-0.429	2.431	-0.209	1.935	0.883
240	2.64	2.538	-0.521	2.669	-0.205	2.149	1.096
300	3.31	3.106	-0.744	2.782	-0.239	2.513	1.341
360	3.97	3.667	-0.868	2.963	-0.236	2.776	1.583
420	4.62	4.293	-1.116	3.029	-0.259	3.179	1.853
480	5.30	4.927	-1.332	3.113	-0.270	3.552	2.126
5[illegible]	5.97	5.514	-1.515	3.192	-0.274	3.880	2.380
6[illegible]	6.70	6.571	-1.823	3.328	-0.277	4.450	2.836
720	8.23	6.958	-2.228	3.155	-0.320	4.951	3.003
840	10.11	7.191	-2.321	3.166	-0.322	5.101	3.104
960	11.76	7.380	-2.417	3.160	-0.327	5.244	3.185
1080	13.33	7.398	-2.504	3.111	-0.338	5.336	3.193
1200	14.83	6.716	-2.309	3.030	-0.343	4.972	2.899
1214	15.00	6.663	-2.282	3.030	-0.342	4.931	2.876

Table 3 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : ~~89-117MU~~
Sample Number : S-1
Depth : 7.0'-9.0'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.09	0.893	0.321	1.532	0.360	1.900	0.386
30	0.21	1.450	0.487	1.958	0.336	1.872	0.626
45	0.38	1.734	0.551	2.196	0.318	1.878	0.748
60	0.57	1.980	0.593	2.408	0.300	1.897	0.854
90	0.90	2.417	0.538	2.654	0.223	2.060	1.043
120	1.26	2.851	0.451	2.840	0.159	2.255	1.231
150	1.59	3.300	0.433	3.106	0.132	2.384	1.424
180	1.92	3.764	0.337	3.263	0.090	2.595	1.625
210	2.28	4.259	0.146	3.297	0.035	2.908	1.838
240	2.59	4.788	0.007	3.402	0.002	3.178	2.066
300	3.25	5.849	-0.241	3.610	-0.041	3.689	2.524
360	3.90	6.967	-0.510	3.776	-0.073	4.235	3.007
420	4.54	8.069	-0.870	3.812	-0.107	4.868	3.483
480	5.20	9.222	-1.173	3.907	-0.127	5.456	3.980
5[illegible]	5.87	10.392	-1.486	3.981	-0.143	6.059	4.485
6[illegible]	6.58	11.555	-1.868	3.987	-0.161	6.729	4.987
720	8.08	13.811	-2.609	3.997	-0.188	8.028	5.961
840	9.93	15.710	-3.256	3.989	-0.207	9.145	6.781
960	11.55	17.568	-3.670	4.099	-0.208	10.019	7.583
1080	13.09	18.611	-3.670	4.283	-0.197	10.278	8.033
1200	14.56	17.971	-3.670	4.170	-0.204	10.119	7.756
1237	15.00	17.613	-3.670	4.107	-0.208	10.031	7.602



LL - 28	PL - 22	PI - 6	Gs - 2.71	NAT w - %

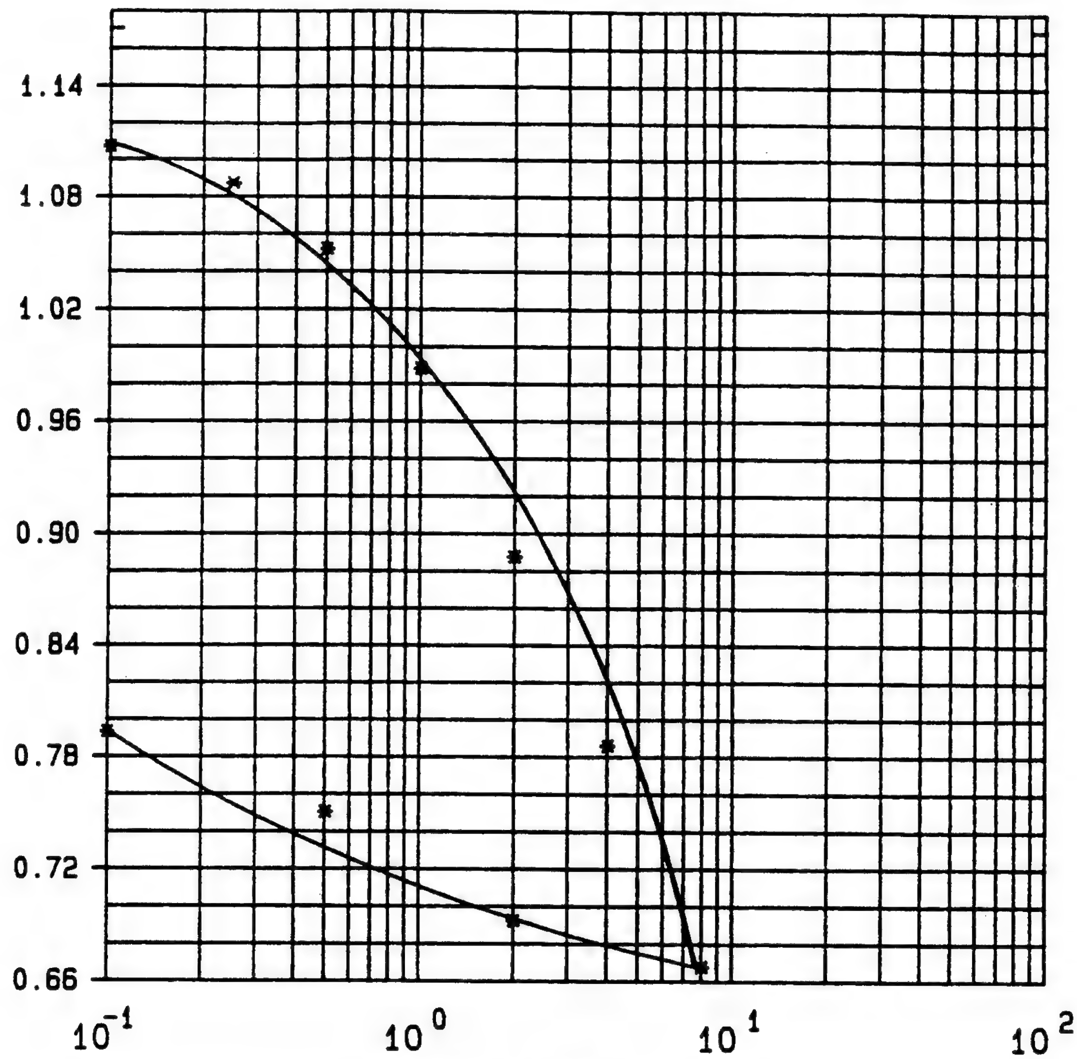
CLASSIFICATION Silt, ML

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	~~89-147 MU~~
SAMPLE NO.	S-1
DEPTH/ELEV	7'-9'
MRD LAB NO.	90/135

GRADATION CURVE

FIGURE 4

Coefficient of Permeability, k_{20}, 10^{-} cm/sec

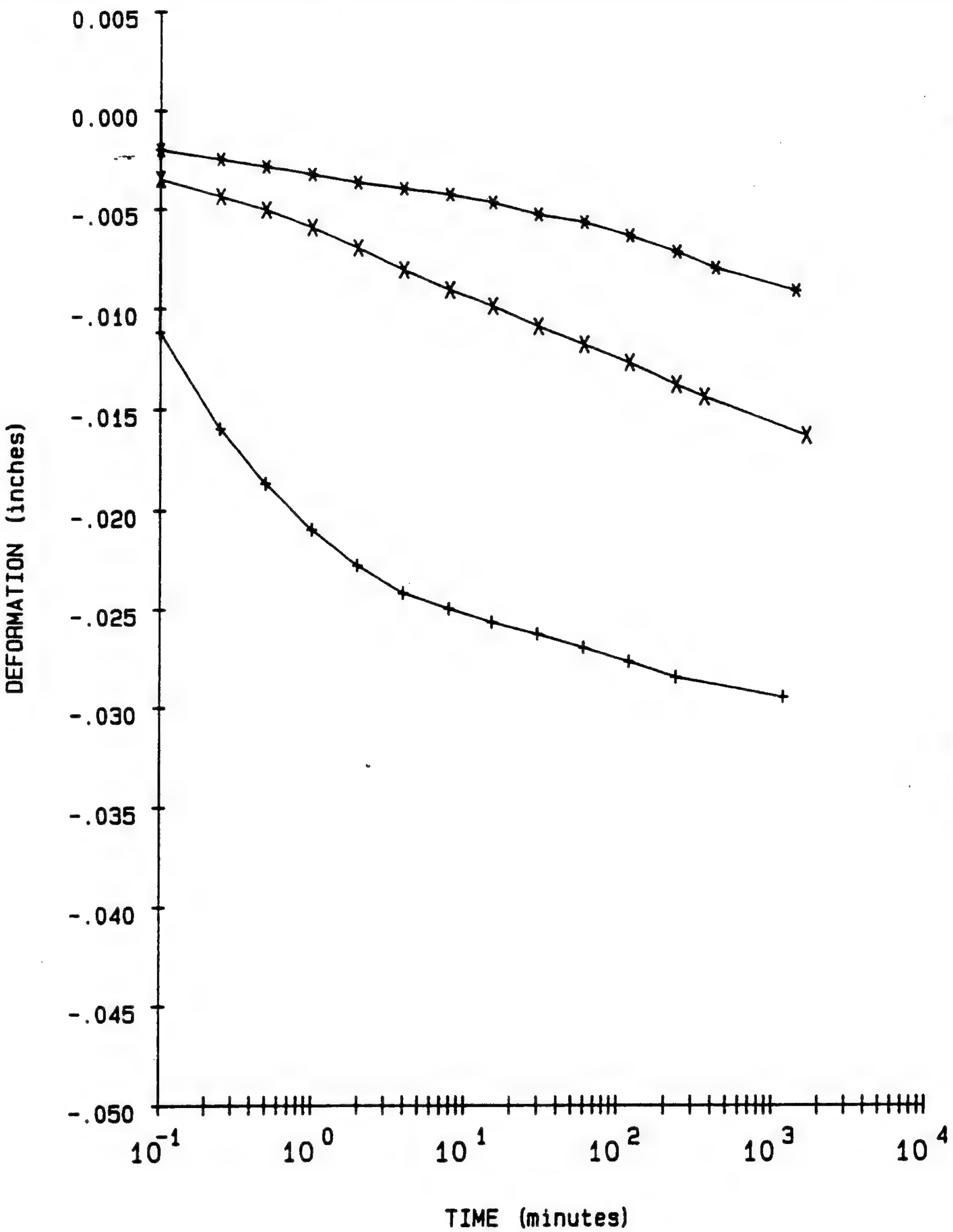


Pressure, p, T/sq ft

Type of Specimen UNDISTURBC			Before Test		After Test	
Diam 4.3 in.	Ht 1 in.		Water Content, w_o	42.6 %	w_f	30.8 %
Overburden Pressure, p_o	T/sq ft		Void Ratio, e_o	1.17	e_f	0.79
Preconsol. Pressure, p_c	T/sq ft		Saturation, S_o	98 %	S_f	100 %
Compression Index, C_c			Dry Density, γ_d	77.6 lb/ft^3		
Classification Fat clay, CH			k_{20} at e_o =	× 10^{-} cm/sec		
LL 73	G_s 2.7		Project	MINNESOTA RIVER; IA-90-04-ED GH		
PL 28	D_{10}					
Remarks Dark brown. Torvane=0.4TSF			Area	MRD LAB NO. 90/135		
Slightly organic. Non-calcareous			Boring No.	89-119MU	Sample No.	S-1
			Depth El	2.0'-4.0'	Date	
			CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 17



LEGEND

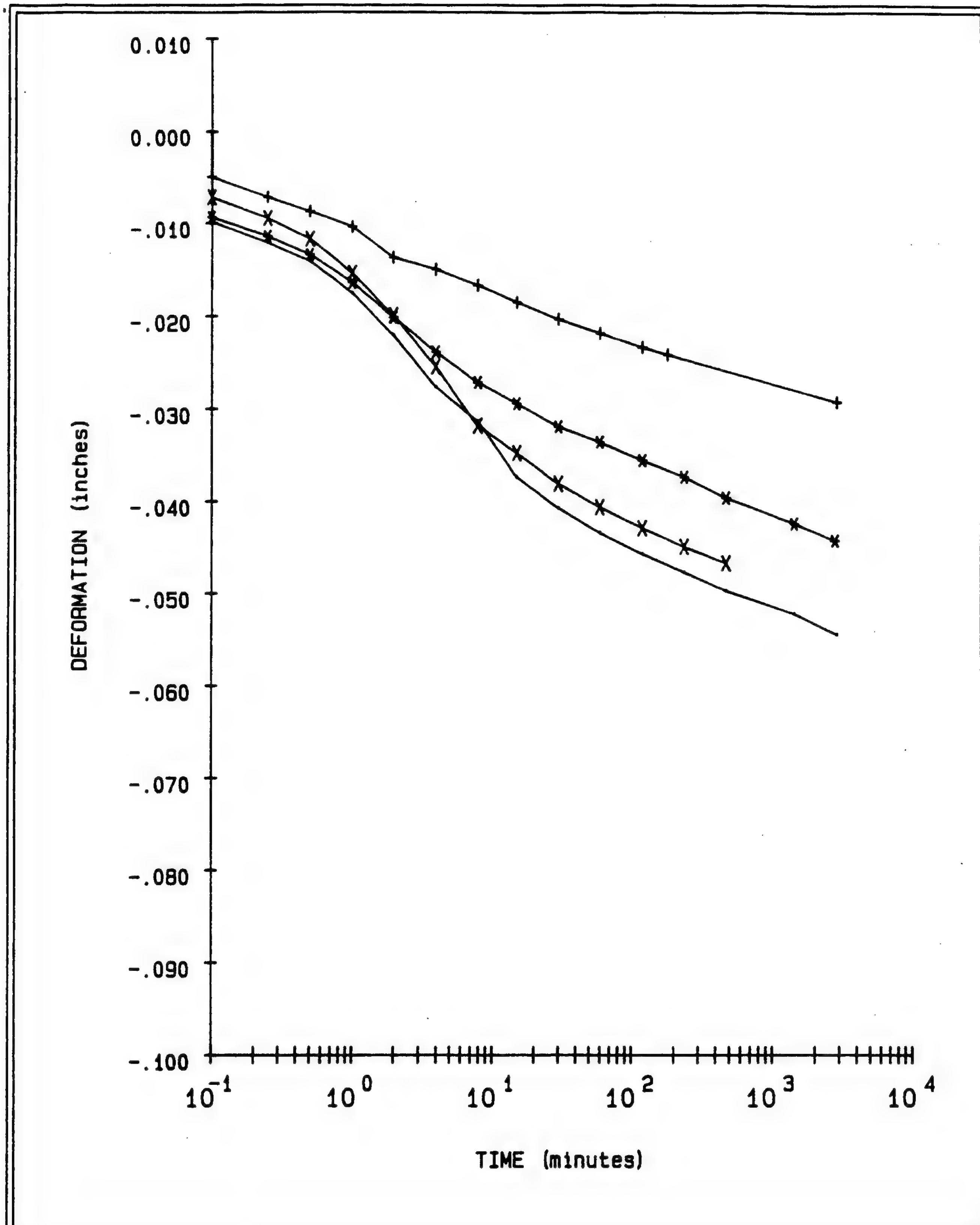
+ = .1 TSF

* = .25 TSF

X = .5 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-119MU
SAMPLE NO.	S-1
DEPTH/ELEV	2.0'-4.0'
MRD LAB NO.	90/135

FIGURE 18



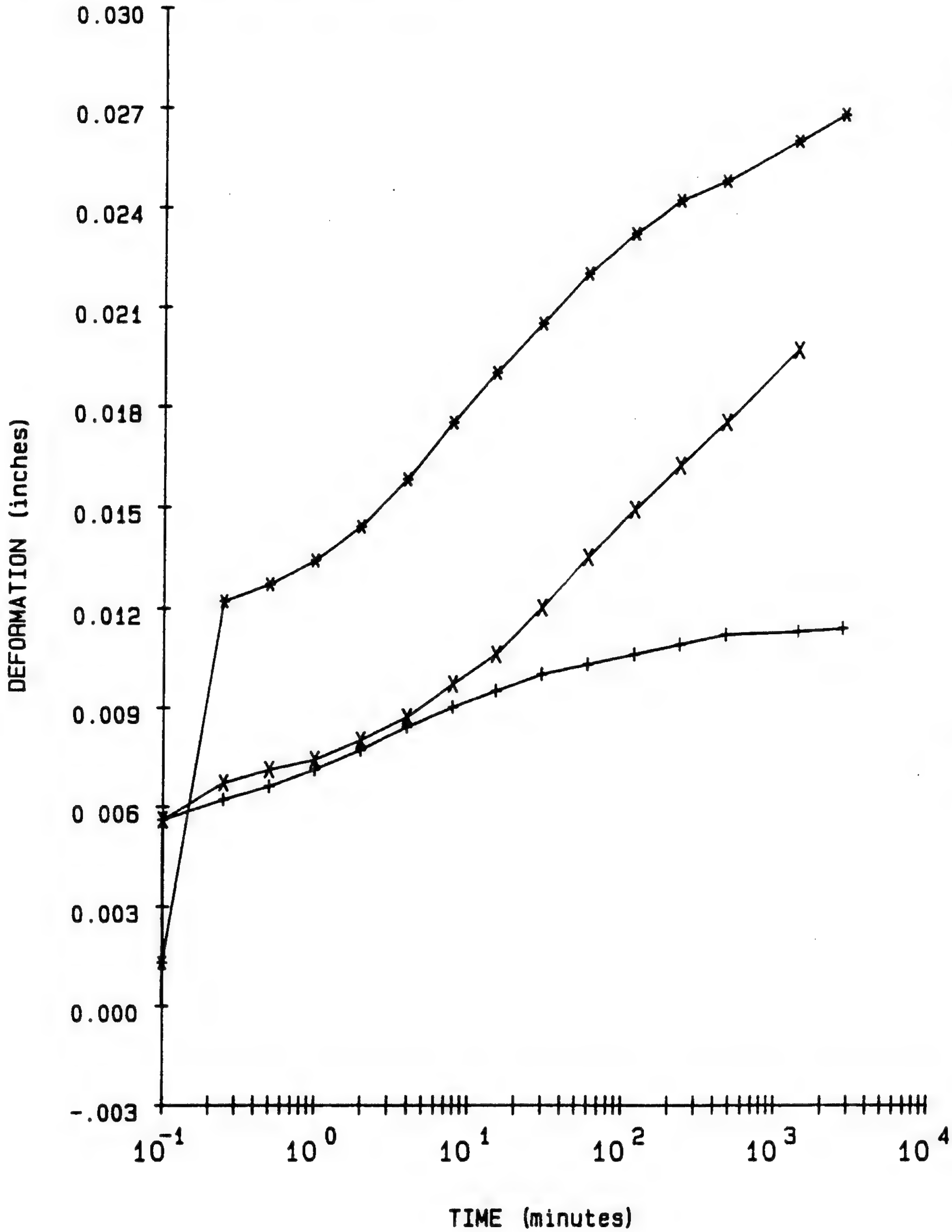
LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF
- = 8 TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-119MU
SAMPLE NO.	S-1
DEPTH/ELEV	2.0'-4.0'
MRD LAB NO.	90/135

FIGURE 19

Figure C-407



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-119MU
SAMPLE NO.	S-1
DEPTH/ELEV	2.0'-4.0'
MRD LAB NO.	90/125

FIGURE 20

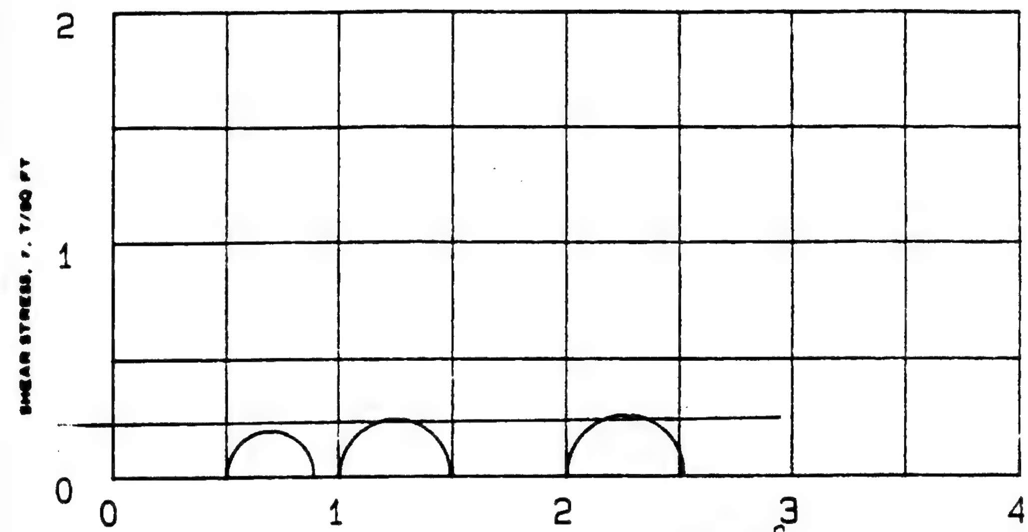
Consolidation Test Data

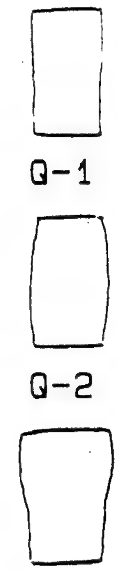
Project	MINNESOTA RIVER; IA-90-04-ED-GH
Boring No.	89-119MU
Sample No.	S-1
Depth/Elev	2.0'-4.0'
MRD Lab No.	90/135

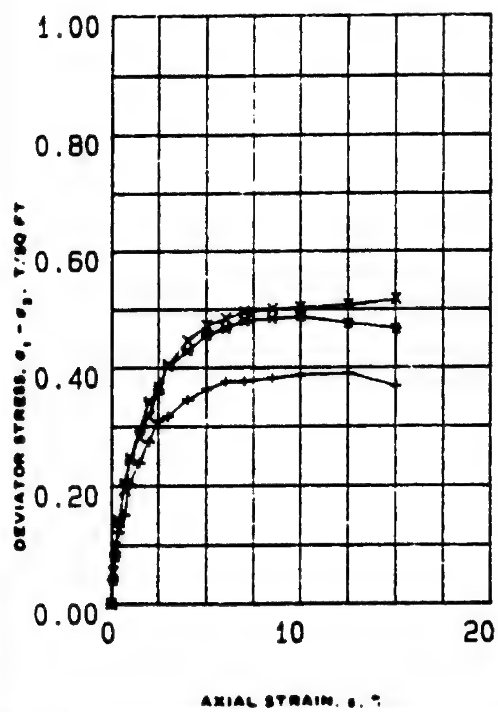
Gs = 2.7
eo = 1.171
0.42eo = 0.492

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
42.6	291.7	77.6	1.171		98.2
41.1	291.7	80.0	1.107	0.10	100.0
41.1	291.7	80.7	1.087	0.25	100.0
41.1	291.7	82.1	1.052	0.50	100.0
41.1	291.7	84.7	0.988	1.00	100.0
41.1	291.7	89.1	0.892	2.00	100.0
41.1	291.7	94.1	0.790	4.00	100.0
41.1	291.7	100.8	0.672	8.00	100.0
1.1	291.7	99.3	0.697	2.00	100.0
41.1	291.7	96.0	0.755	0.50	100.0
41.1	291.7	93.7	0.798	0.10	100.0

Axial Strain (%)	Void Ratio
1	1.149
2	1.127
3	1.106
4	1.084
5	1.062
6	1.041
7	1.019
8	0.997
9	0.975
10	0.954
11	0.932
12	0.910
13	0.889
14	0.867
15	0.845
16	0.824
17	0.802
18	0.780
19	0.758
20	0.737







SPECIMEN NO.			1 (+)	2 (×)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	42.8	40.8	41.3	
	DRY DENSITY LB/CU FT	γ_{d_o}	77.0	79.1	81.2	
	SATURATION, %	S_o	97.0	97.0	100.0	
	VOID RATIO	e_o	1.19	1.13	1.08	
BEFORE SHEAR	WATER CONTENT, %	w_c	42.6	41.0	41.3	
	DRY DENSITY LB/CU FT	γ_{d_c}	77.0	79.1	81.2	
	SATURATION, %	S_c	97.0	98.0	100.0	
	VOID RATIO	e_c	1.19	1.13	1.08	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.39	0.49	0.52	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	26.3	21.0	30.8	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.37	0.47	0.52	
INITIAL DIAMETER, IN.		D_o	1.40	1.40	1.40	
INITIAL HEIGHT, IN.		H_o	2.98	2.99	2.94	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH

LL	PL	PI	G_s	TYPE OF SPECIMEN	TYPE OF TEST
73	28	45	2.7	UNDISTURBED	Q

REMARKS: Dark brown. Torvane=0.4TSF. Slightly organic. Non-calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

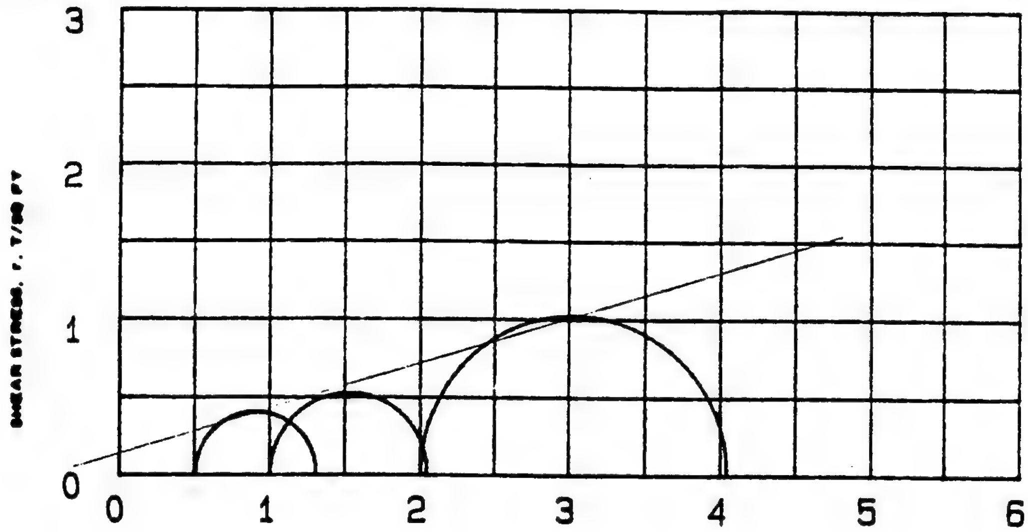
BORING NO. 89-119 MU — SAMPLE NO. S-1

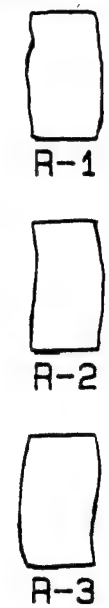
DEPTH ELEV 2'-4'

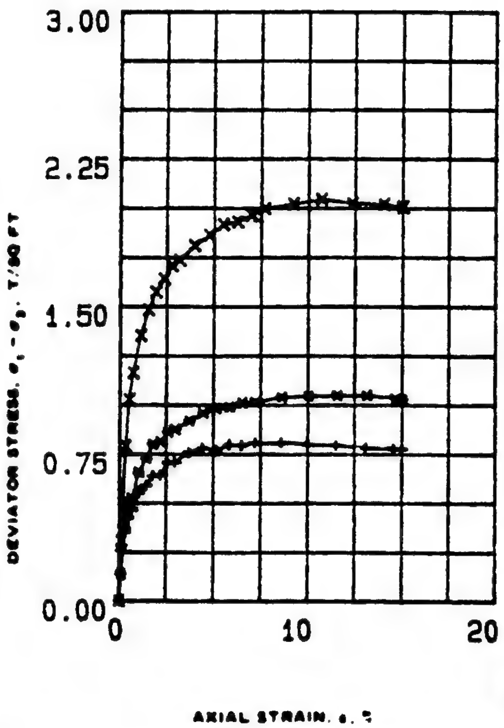
LABORATORY 90/135 — DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 — PREVIOUS EDITION IS OBSOLETE — TRANSLUCENT — *(EM 1110-2-1906)* — FIGURE 21







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	41.9	40.5	42.5	
	DRY DENSITY LB/CU FT	γd_o	77.6	78.6	77.1	
	SATURATION, %	S_o	97	96	97	
	VOID RATIO	e_o	1.17	1.14	1.19	
BEFORE SHEAR	WATER CONTENT, %	w_c	39.7	37.3	33.7	
	DRY DENSITY LB/CU FT	γd_c	81.4	84.9	89.8	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	1.07	.99	.89	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.823	4.823	4.823	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.806	1.047	2.043	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	600	960	840	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.774	1.026	2.004	
INITIAL DIAMETER, IN.		D_o	1.4	1.41	1.41	
INITIAL HEIGHT, IN.		H_o	2.98	2.99	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH B-Value 1.0 1.0 1.0

LL 73	PL 28	PI 45	G_s 2.7	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Dark brown. Torvane=0.4 TSF. Slightly organic. Non-calcareous.

PROJECT MINNESOTA RIVER: IA-90-04-ED-GH

BORING NO 89-119 MU SAMPLE NO. S-1

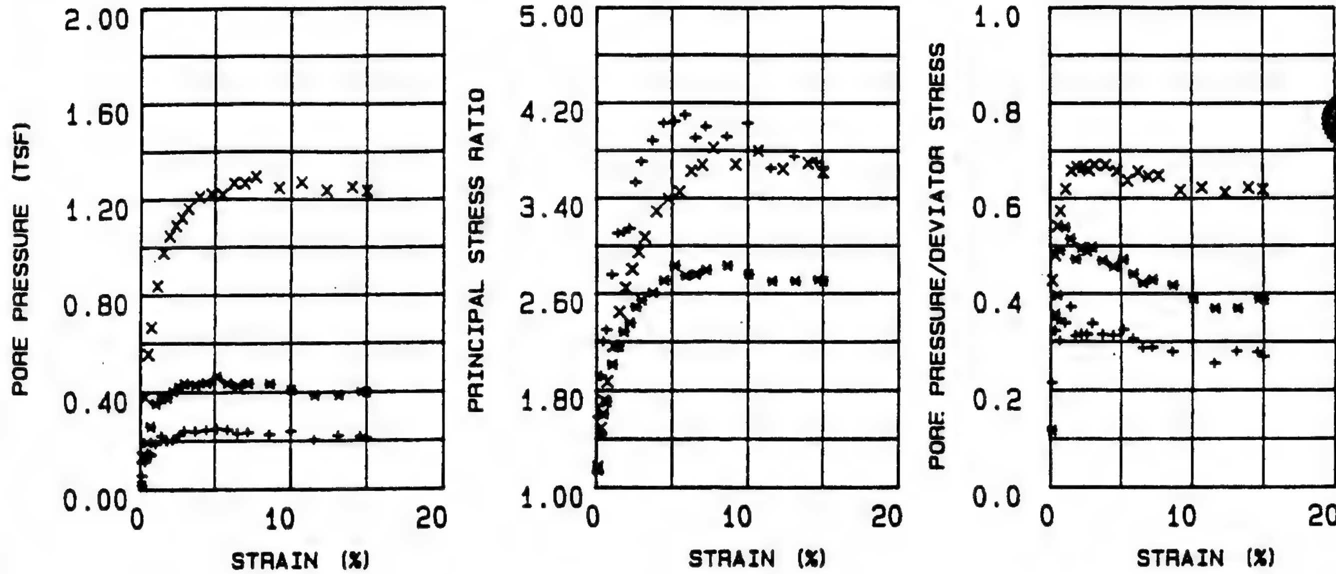
DEPTH ELEV 2'-4'

LABORATORY 90/135 DATE

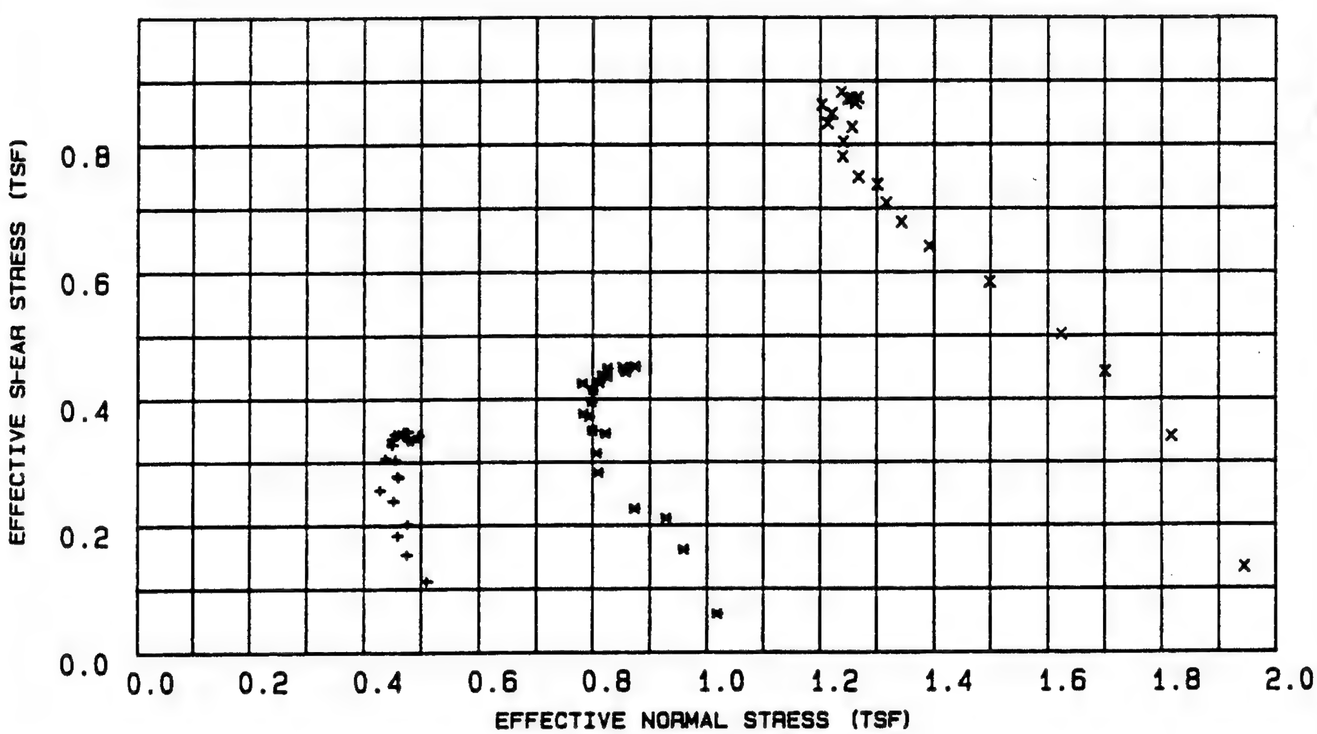
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 22



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF
✱ = 1 TSF
X = 2 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-119 MU
SAMPLE NO.	S-1
DEPTH/ELEV	2'-4'
MRD LAB NO.	90/135

FIGURE 23

R

Table 7 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-119 MU
Sample Number : S-1
Depth : 2'-4'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.258	0.055	1.579	0.215	0.509	0.111
30	0.34	0.354	0.114	1.918	0.322	0.474	0.153
45	0.51	0.424	0.147	2.202	0.346	0.458	0.183
60	0.71	0.467	0.140	2.298	0.301	0.476	0.201
90	1.07	0.552	0.186	2.757	0.338	0.451	0.238
120	1.46	0.590	0.219	3.102	0.372	0.427	0.255
150	1.82	0.638	0.198	3.112	0.311	0.460	0.275
180	2.21	0.641	0.201	3.144	0.314	0.458	0.277
210	2.60	0.705	0.221	3.531	0.314	0.454	0.304
240	2.97	0.708	0.238	3.706	0.337	0.437	0.306
300	3.70	0.757	0.237	3.881	0.314	0.450	0.327
360	4.43	0.779	0.243	4.026	0.312	0.450	0.336
420	5.13	0.767	0.248	4.041	0.324	0.442	0.331
[illegible]	5.84	0.797	0.243	4.096	0.305	0.454	0.344
540	6.52	0.793	0.227	3.901	0.286	0.469	0.342
600	7.20	0.806	0.231	3.995	0.287	0.469	0.348
720	8.59	0.806	0.223	3.913	0.278	0.476	0.348
840	10.00	0.796	0.237	4.029	0.299	0.460	0.344
960	11.53	0.792	0.201	3.648	0.254	0.495	0.342
1080	13.08	0.778	0.217	3.750	0.279	0.476	0.336
1200	14.57	0.774	0.214	3.703	0.277	0.478	0.334
1232	15.00	0.774	0.207	3.643	0.268	0.485	0.334

Table 8 - Triaxial $\bar{R}$ Test Results

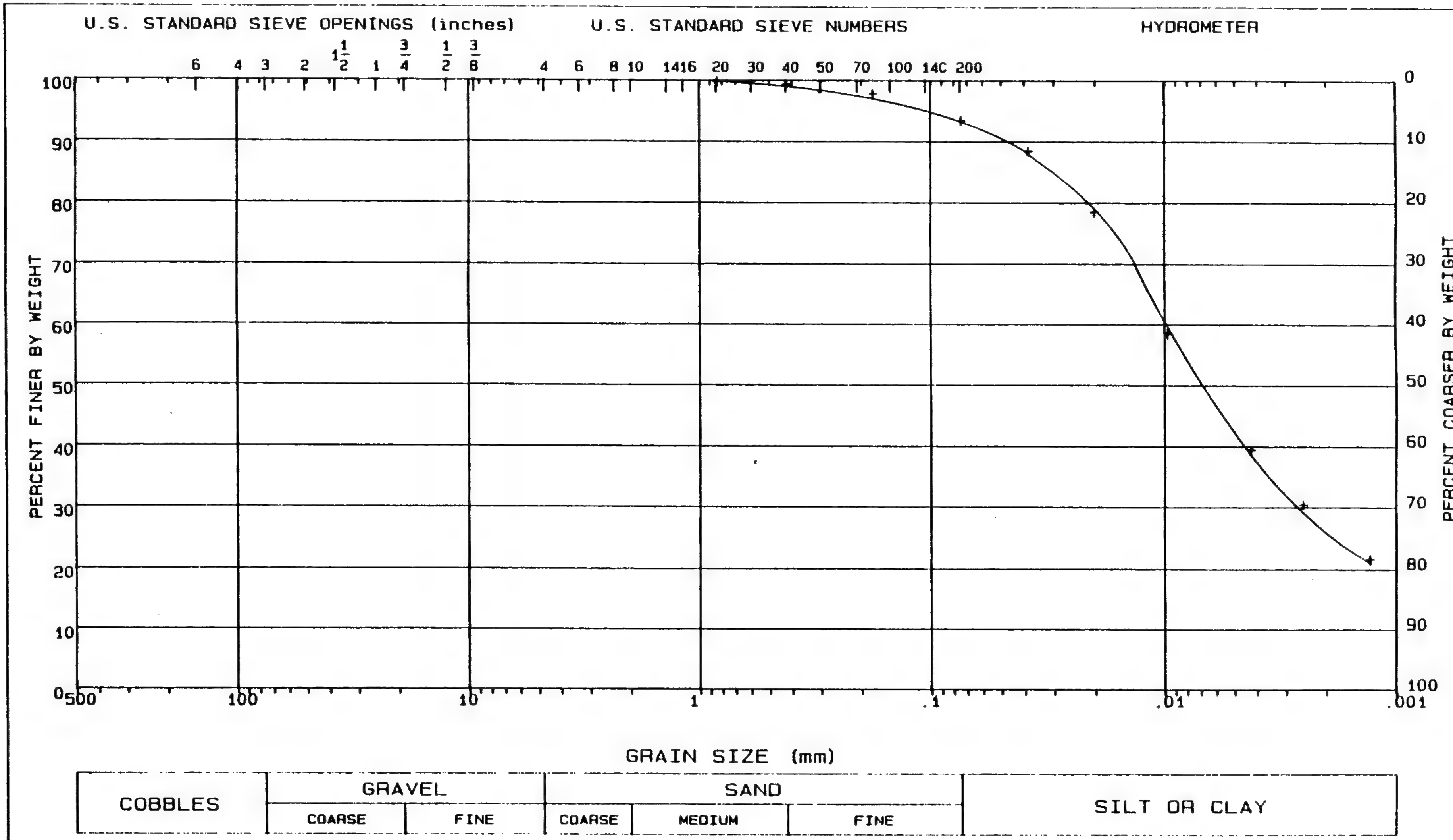
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-119 MU
Sample Number : S-1
Depth : 2'-4'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.138	0.016	1.141	0.116	1.018	0.060
30	0.34	0.372	0.133	1.430	0.357	0.959	0.161
45	0.51	0.488	0.193	1.605	0.396	0.928	0.211
60	0.71	0.525	0.257	1.706	0.490	0.873	0.226
90	1.08	0.656	0.353	2.013	0.538	0.809	0.283
120	1.47	0.728	0.374	2.162	0.514	0.806	0.314
150	1.83	0.799	0.376	2.280	0.471	0.822	0.345
180	2.23	0.811	0.402	2.358	0.496	0.799	0.350
210	2.62	0.862	0.420	2.487	0.488	0.793	0.372
240	2.98	0.875	0.434	2.546	0.497	0.783	0.377
300	3.72	0.918	0.429	2.607	0.468	0.798	0.396
360	4.45	0.960	0.438	2.708	0.456	0.800	0.414
420	5.16	0.984	0.463	2.830	0.471	0.781	0.425
480	5.87	0.988	0.434	2.746	0.440	0.811	0.426
5[illegible]0	6.56	1.011	0.425	2.759	0.421	0.825	0.436
[illegible]	7.24	1.015	0.434	2.794	0.428	0.817	0.438
720	8.64	1.040	0.432	2.833	0.416	0.826	0.449
840	10.05	1.045	0.406	2.759	0.389	0.853	0.451
960	11.59	1.047	0.385	2.701	0.368	0.874	0.452
1080	13.16	~~1.047~~	~~0.385~~	2.701	0.368	0.874	0.452
1200	14.65	1.031	0.399	2.714	0.387	0.856	0.445
1226	15.00	1.026	0.396	2.700	0.386	0.858	0.443

Table 9 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-119 MU
Sample Number : S-1
Depth : 2'-4'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.13	0.307	0.131	1.164	0.427	1.945	0.133
30	0.36	0.788	0.378	1.486	0.480	1.817	0.340
45	0.55	1.026	0.554	1.710	0.541	1.700	0.443
60	0.76	1.162	0.665	1.871	0.573	1.623	0.502
90	1.15	1.353	0.837	2.164	0.619	1.498	0.584
120	1.56	1.483	0.976	2.447	0.658	1.391	0.640
150	1.95	1.572	1.046	2.648	0.666	1.343	0.678
180	2.37	1.640	1.090	2.802	0.665	1.316	0.708
210	2.78	1.707	1.123	2.946	0.659	1.300	0.737
240	3.18	1.735	1.162	3.071	0.670	1.267	0.749
300	3.96	1.809	1.209	3.287	0.669	1.239	0.781
360	4.74	1.863	1.221	3.392	0.656	1.240	0.804
420	5.49	1.917	1.218	3.451	0.636	1.256	0.827
480	6.25	1.931	1.265	3.626	0.655	1.213	0.833
540	6.98	1.964	1.266	3.676	0.645	1.220	0.848
	7.70	1.997	1.292	3.819	0.647	1.202	0.862
720	9.19	2.021	1.245	3.678	0.616	1.255	0.872
840	10.70	2.043	1.269	3.795	0.622	1.237	0.882
960	12.34	2.023	1.235	3.642	0.611	1.266	0.873
1080	14.00	2.017	1.251	3.694	0.621	1.248	0.871
1155	15.00	2.004	1.234	3.617	0.617	1.262	0.865
1155	15.00	2.004	1.234	3.617	0.617	1.262	0.865



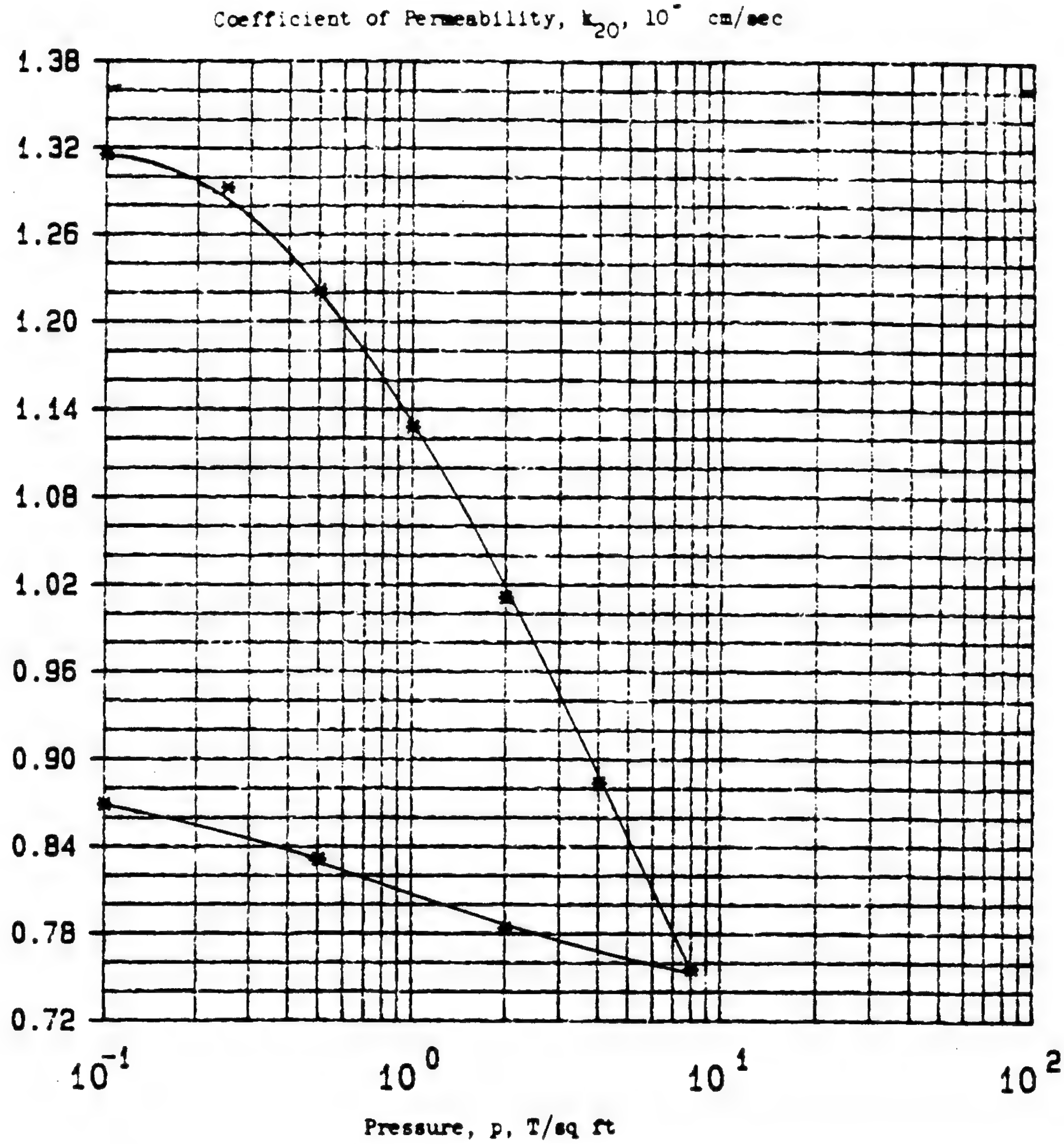
LL = 73	PL = 28	PI = 45	Gs = 2.7	NAT w = %

CLASSIFICATION Fat clay, CH

GRADATION CURVE

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-119 MU
SAMPLE NO.	S-1
DEPTH/ELEV	2'-4'
MRD LAB NO.	90/135

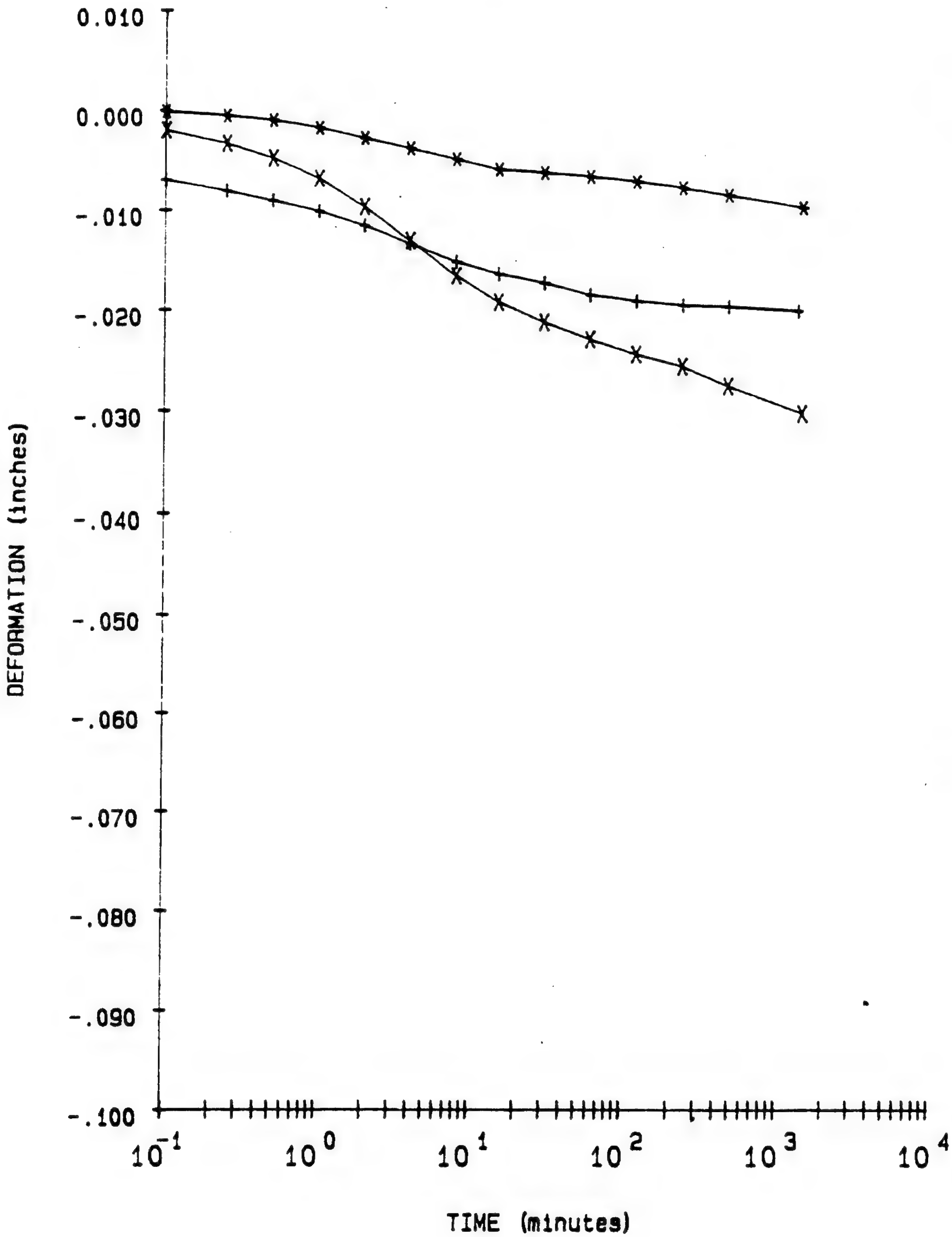
FIGURE 24



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.4 in.	Ht 1 in.	Water Content, w_o	55.3 %	w_f	35.7 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.36	e_f	0.87
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	100 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	71.3 lb/ft^3		
Classification Fat clay, CH		k_{20} at e_o = × 10^{-} cm/sec			
LL 68	G_s 2.7	Project	MINNESOTA RIVER: IA-90-04-ED-GH		
PL 26	D_{10}				
Remarks Dark gray. Torvane=0.15		Area	MRD LAB NO. 90/135		
TSF. Slightly calcareous. Slightly		Boring No.	89-119MU	Sample No.	S-3
organic. Numerous shell fragments.		Depth El	11'-13'	Date	
		CONSOLIDATION TEST REPORT			

ENG FORM 2090 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 1

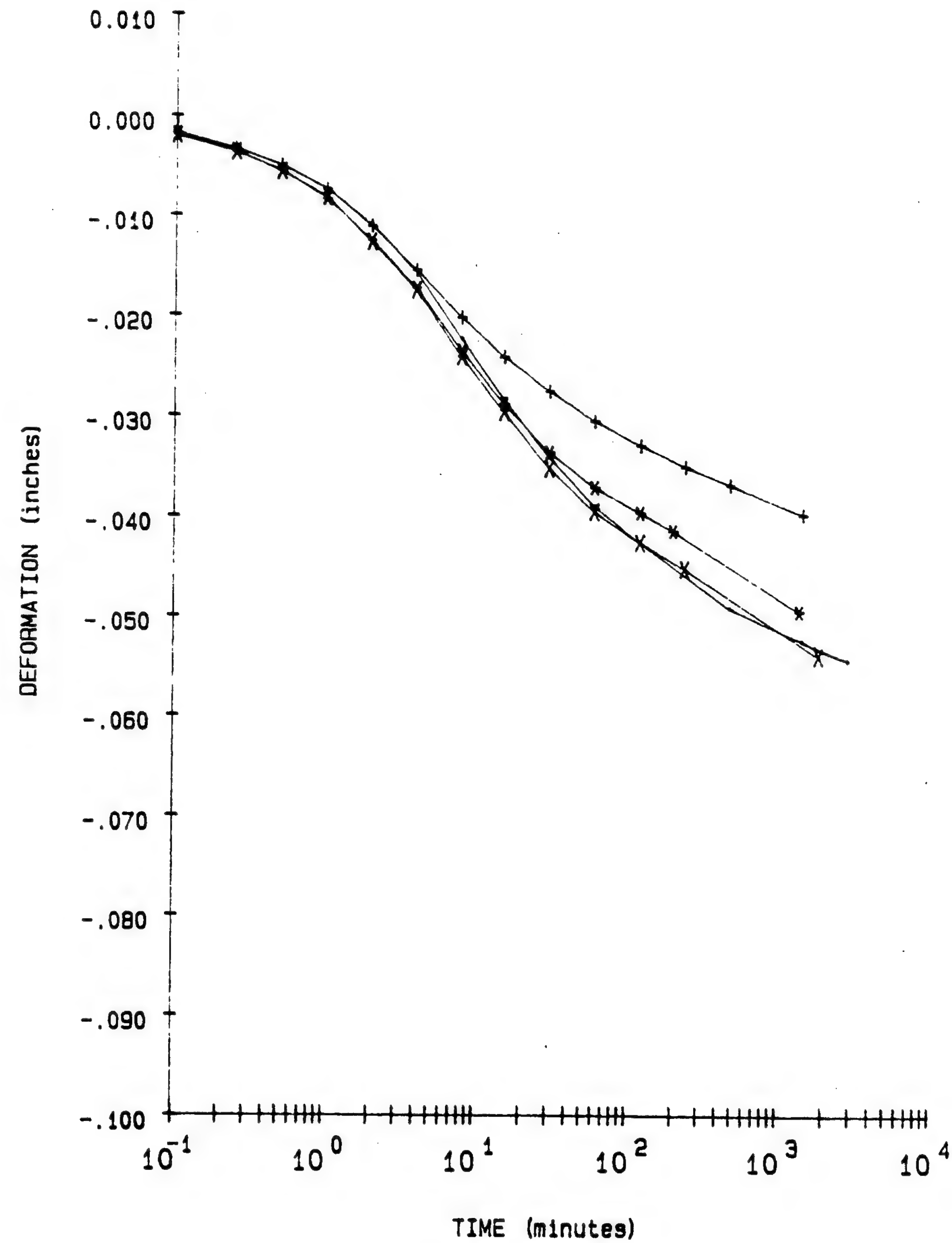


LEGEND

+ = .1 TSF
* = .25 TSF
X = .5 TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-119MU
SAMPLE NO.	S-3
DEPTH/ELEV	11'-13'
MRD LAB NO.	90/135

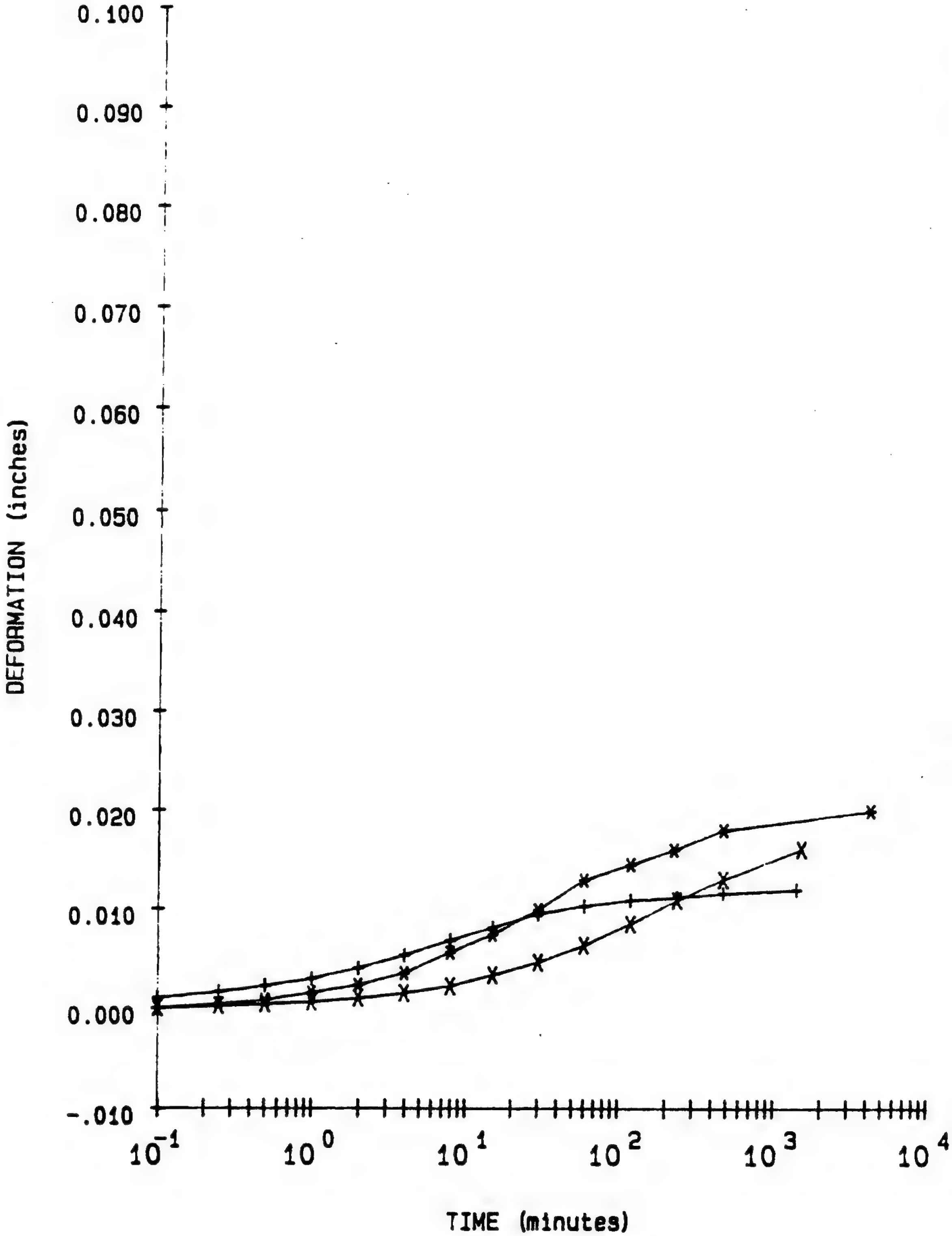
FIGURE 2



LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-119MU
SAMPLE NO.	S-3
DEPTH/ELEV	11'-13'
MRD LAB NO.	90/135

FIGURE 3



LEGEND

+ =	2	TSF	Rebound
* =	.5	TSF	Rebound
X =	.1	TSF	Rebound

PROJECT	MIN ESOTA RIVER: IA-90-04-ED-6H
BORING NO.	89-119MU
SAMPLE NO.	S-3
DEPTH/ELEV	11'-13'
MRD LAB NO.	90/135

FIGURE 4

Consolidation Test Data

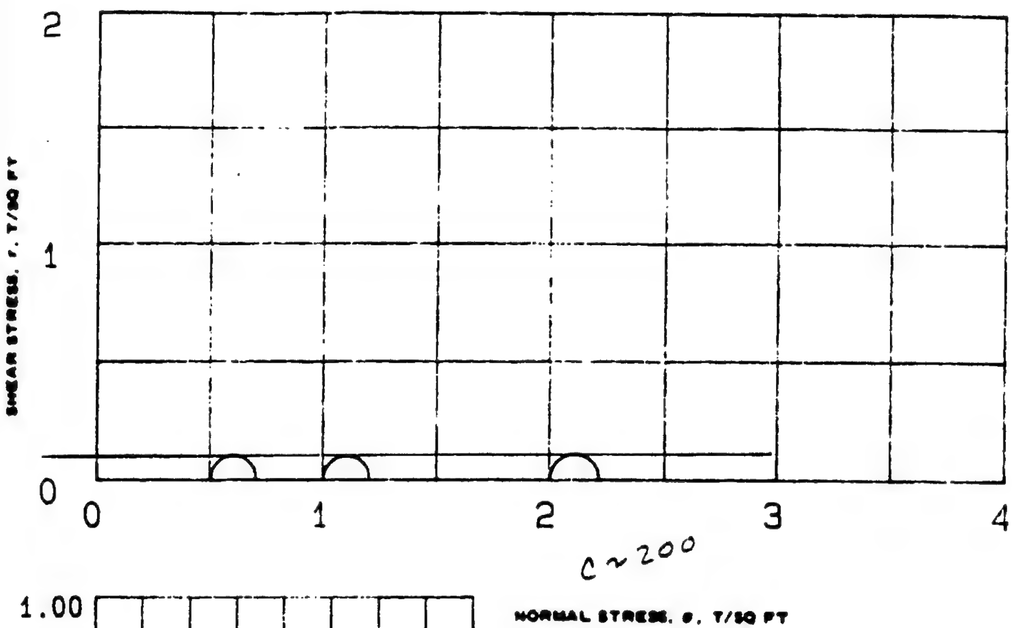
Project MINNESOTA RIVER; IA-90-04-ED-GH

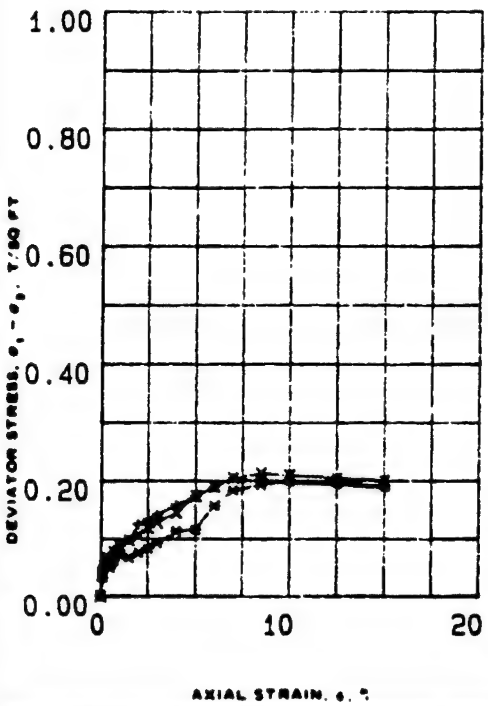
Boring No. 89-119MU
Sample No. S-3
Depth/Elev 11'-13'
MRD Lab No. 90/135

Gs = 2.7
eo = 1.363
0.42eo = 0.572

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
55.3	289.7	71.3	1.363		100.0
35.7	289.7	72.8	1.315	0.10	73.3
35.7	289.7	73.5	1.293	0.25	74.6
35.7	289.7	75.8	1.221	0.50	78.9
35.7	289.7	79.2	1.127	1.00	85.5
35.7	289.7	83.8	1.011	2.00	95.4
35.7	289.7	89.5	0.883	4.00	100.0
35.7	289.7	96.0	0.755	8.00	100.0
35.7	289.7	94.5	0.783	2.00	100.0
35.7	289.7	92.0	0.831	0.50	100.0
35.7	289.7	90.2	0.869	0.10	100.0

Axial Strain (%)	Void Ratio
1	1.339
2	1.315
3	1.292
4	1.268
5	1.244
6	1.221
7	1.197
8	1.174
9	1.150
10	1.126
11	1.103





SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	56.7	57.7	57.2	
	DRY DENSITY LB/CU FT	γ_{d_o}	68.7	68.0	67.7	
	SATURATION, %	S_o	100.0	100.0	100.0	
	VOID RATIO	e_o	1.45	1.48	1.49	
BEFORE SHEAR	WATER CONTENT, %	w_c	56.3	56.9	56.2	
	DRY DENSITY LB/CU FT	γ_{d_c}	68.7	68.0	67.7	
	SATURATION, %	S_c	100.0	100.0	100.0	
	VOID RATIO	e_c	1.45	1.48	1.49	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.21	0.20	0.21	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	14.5	19.5	17.5	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.19	0.19	0.20	
INITIAL DIAMETER, IN.		D_o	1.40	1.42	1.40	
INITIAL HEIGHT, IN.		H_o	2.97	2.98	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH

LL 68	PL 26	PI 42	Gs 2.7	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Dark gray. Torvane=0.15 TSF. Slightly calcareous. Slightly organic. Numerous shell fragments.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

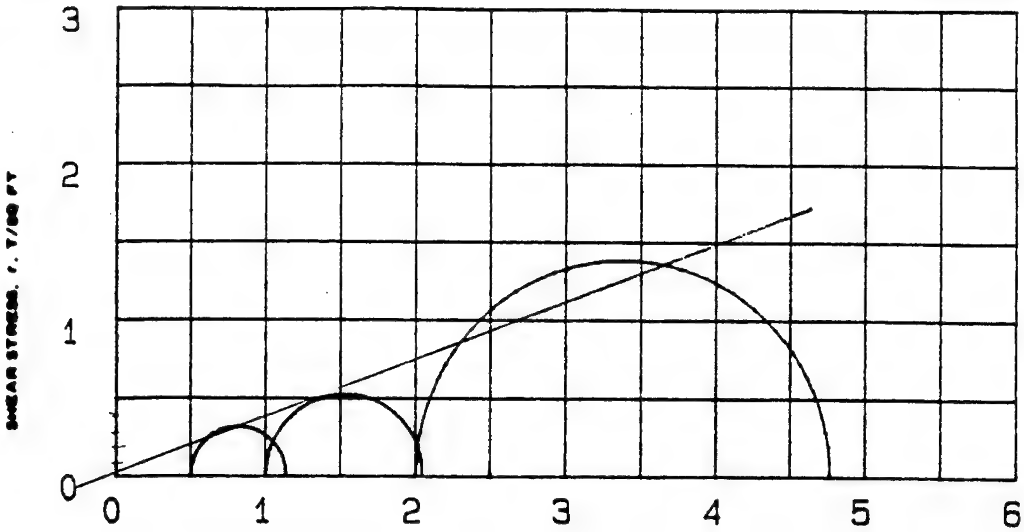
BORING NO. 89-119 MU | SAMPLE NO. S-3

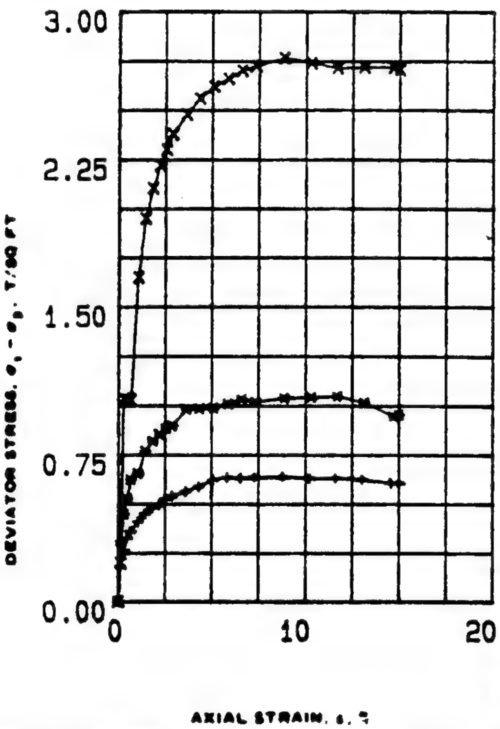
DEPTH ELEV 11'-13'

LABORATORY 90/135 | DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 5





NORMAL STRESS, σ, T/SQ FT

			1 (+)	2 (*)	3 (X)
SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	50.8	51.9	47.7
	DRY DENSITY LB/CU FT	γ_{d_o}	71.4	69.6	72.9
	SATURATION, %	S_o	100	98	98
	VOID RATIO	e_o	1.36	1.42	1.31
BEFORE SHEAR	WATER CONTENT, %	w_c	43.2	42.2	38.8
	DRY DENSITY LB/CU FT	γ_{d_c}	78	78.8	82.1
	SATURATION, %	S_c	100	100	100
	VOID RATIO	e_c	1.16	1.14	1.05
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.823	4.823	4.823
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.637	1.048	2.768
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	720	960	720
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.604	0.954	2.705
INITIAL DIAMETER, IN.		D_o	1.41	1.42	1.4
INITIAL HEIGHT, IN.		H_o	2.97	2.98	2.98

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH B-Value 1.0 1.0 1.0

LL	PL	PI	G_s
68	26	42	2.7

TYPE OF SPECIMEN UNDISTURBED TYPE OF TEST RBAR

REMARKS: Dark gray. Torvane=0.15 TSF. Slightly calcareous. Slightly organic. Numerous shell fragments.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

BORING NO 89-119 MU SAMPLE NO. S-3

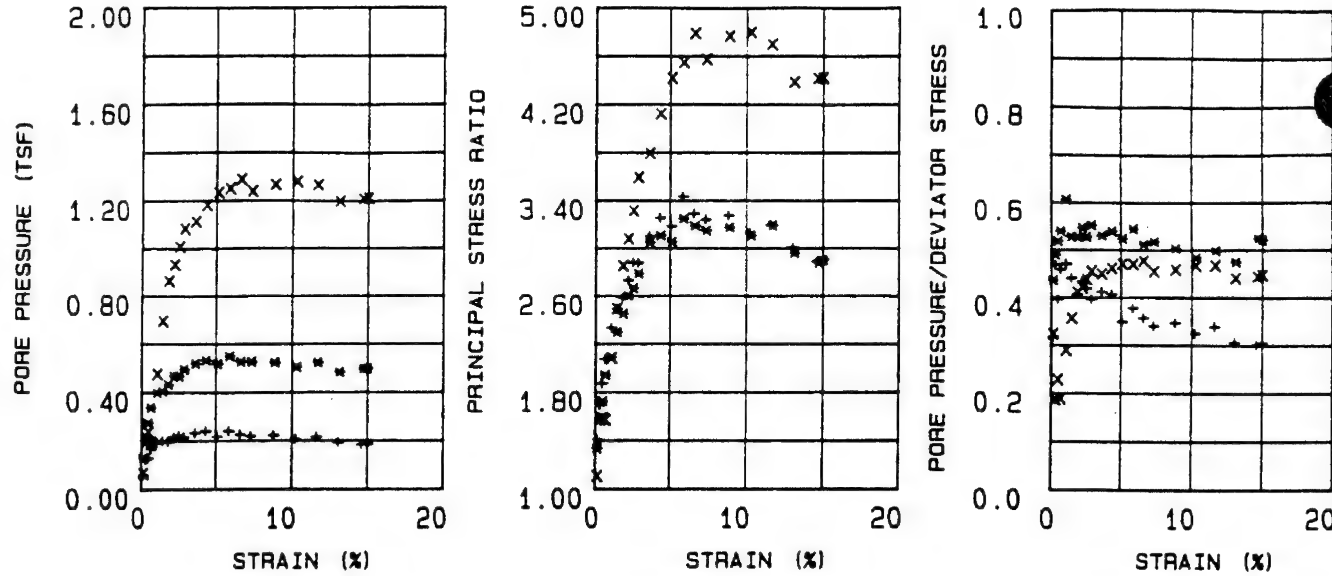
DEPTH ELEV 11'-13'

LABORATORY 90/135 DATE

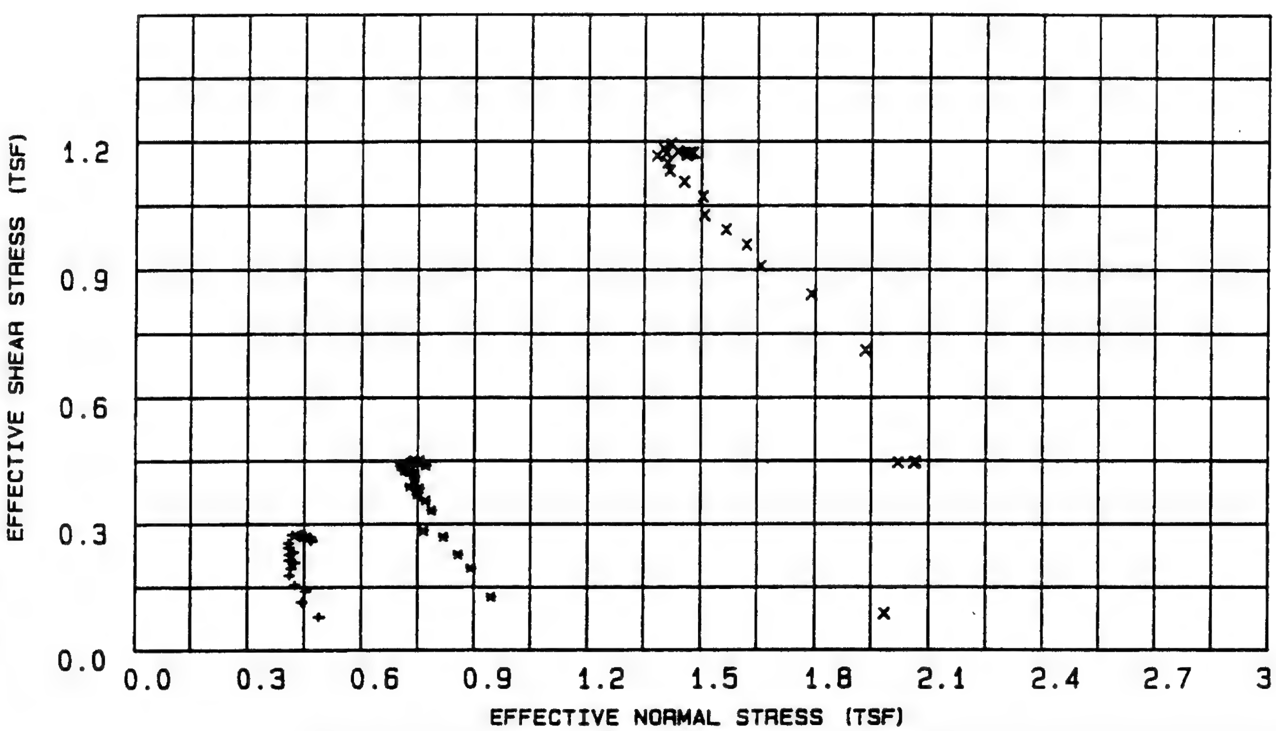
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 6



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF

* = 1 TSF

X = 2 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-119 MU
SAMPLE NO.	S-3
DEPTH/ELEV	11'-13'
MRD LAB NO.	90/135

FIGURE 7

R

Table 1 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-119 MU
Sample Number : S-3
Depth : 11'-13'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.15	0.180	0.057	1.406	0.316	0.488	0.078
30	0.32	0.262	0.122	1.693	0.468	0.443	0.113
45	0.49	0.325	0.128	1.873	0.395	0.452	0.140
60	0.69	0.359	0.165	2.072	0.458	0.424	0.155
90	1.08	0.410	0.192	2.331	0.470	0.409	0.177
120	1.45	0.451	0.198	2.492	0.440	0.414	0.194
150	1.84	0.482	0.195	2.580	0.406	0.424	0.208
180	2.21	0.495	0.214	2.730	0.433	0.408	0.213
210	2.53	0.526	0.220	2.879	0.418	0.410	0.227
240	2.88	0.539	0.213	2.876	0.395	0.420	0.233
300	3.61	0.564	0.232	3.101	0.411	0.408	0.243
360	4.32	0.589	0.239	3.253	0.406	0.407	0.254
420	5.06	0.621	0.216	3.183	0.348	0.438	0.268
4[illegible]	5.82	0.635	0.239	3.431	0.377	0.418	0.274
540	6.56	0.631	0.224	3.289	0.356	0.432	0.272
600	7.29	0.636	0.216	3.237	0.339	0.442	0.275
720	8.79	0.637	0.220	3.273	0.346	0.438	0.275
840	10.22	0.629	0.204	3.125	0.324	0.452	0.272
960	11.60	0.630	0.213	3.193	0.338	0.443	0.272
1080	13.02	0.622	0.189	3.002	0.305	0.465	0.268
1200	14.57	0.603	0.181	2.888	0.300	0.468	0.260
1231	15.00	0.604	0.183	2.907	0.304	0.466	0.261

Table 2 - Triaxial $\overline{R}$ Test Results

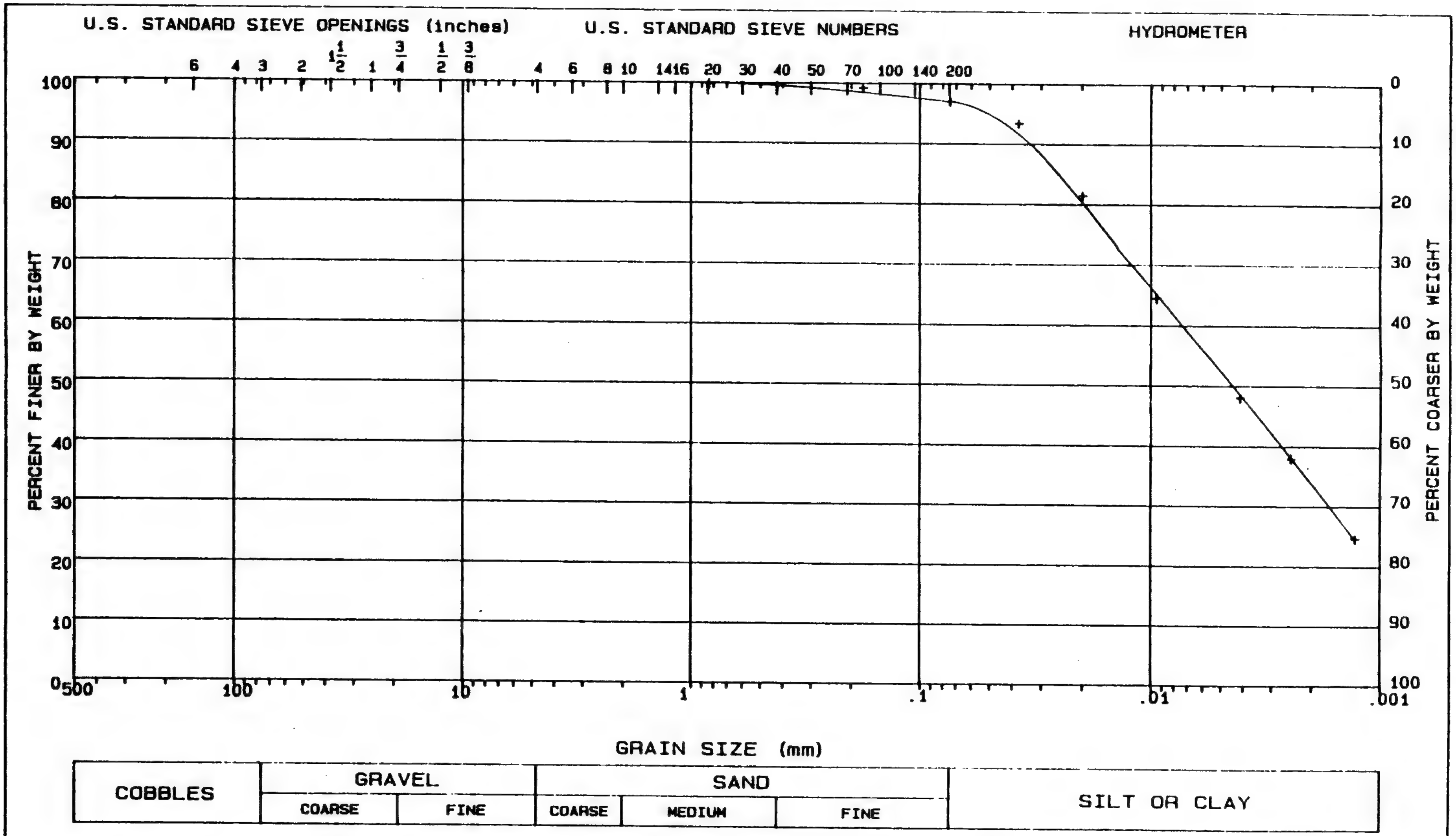
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-119 MU
Sample Number : S-3
Depth : 11'-13'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.15	0.291	0.127	1.333	0.435	0.945	0.126
30	0.32	0.449	0.219	1.576	0.489	0.892	0.194
45	0.50	0.527	0.273	1.725	0.518	0.857	0.227
60	0.69	0.624	0.336	1.940	0.539	0.818	0.269
90	1.09	0.657	0.398	2.091	0.606	0.765	0.284
120	1.46	0.770	0.405	2.294	0.527	0.786	0.332
150	1.86	0.822	0.433	2.450	0.527	0.770	0.355
180	2.23	0.854	0.467	2.602	0.547	0.745	0.369
210	2.55	0.887	0.467	2.664	0.527	0.753	0.383
240	2.90	0.900	0.496	2.787	0.552	0.727	0.388
300	3.64	0.982	0.520	3.048	0.530	0.723	0.424
360	4.36	0.987	0.532	3.106	0.539	0.712	0.426
420	5.11	0.990	0.517	3.052	0.523	0.728	0.427
480	5.88	1.012	0.550	3.248	0.544	0.701	0.437
5[illegible]	6.62	1.034	0.527	3.187	0.511	0.729	0.44[illegible]
6[illegible]	7.36	1.018	0.526	3.146	0.517	0.726	0.439
720	8.88	1.040	0.522	3.174	0.502	0.735	0.449
840	10.32	1.044	0.503	3.102	0.483	0.755	0.451
960	11.71	1.048	0.522	3.191	0.498	0.738	0.452
1080	13.14	1.015	0.481	2.956	0.474	0.770	0.438
1200	14.71	0.946	0.495	2.872	0.524	0.739	0.408
1221	15.00	0.954	0.497	2.897	0.521	0.739	0.412

Table 3 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-119 MU
Sample Number : S-3
Depth : 11'-13'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.15	0.199	0.064	1.103	0.323	1.985	0.086
30	0.32	1.035	0.192	1.573	0.186	2.064	0.447
45	0.50	1.032	0.235	1.585	0.228	2.020	0.445
60	0.69	1.028	0.192	1.568	0.188	2.062	0.444
90	1.09	1.648	0.475	2.081	0.289	1.933	0.711
120	1.46	1.951	0.694	2.494	0.356	1.789	0.842
150	1.85	2.105	0.863	2.851	0.411	1.658	0.908
180	2.22	2.221	0.931	3.077	0.420	1.619	0.958
210	2.55	2.301	1.006	3.314	0.438	1.564	0.993
240	2.89	2.380	1.082	3.593	0.455	1.507	1.027
300	3.63	2.479	1.112	3.793	0.449	1.502	1.070
360	4.35	2.561	1.180	4.123	0.461	1.454	1.105
420	5.09	2.621	1.233	4.419	0.471	1.416	1.131
480	5.86	2.662	1.249	4.547	0.470	1.410	1.149
[illegible]	6.60	2.702	1.287	4.789	0.477	1.382	1.166
[illegible]	7.34	2.725	1.237	4.571	0.454	1.438	1.176
720	8.85	2.766	1.265	4.765	0.458	1.420	1.194
840	10.29	2.740	1.278	4.794	0.467	1.400	1.182
960	11.67	2.714	1.265	4.695	0.467	1.407	1.172
1080	13.11	2.719	1.196	4.382	0.440	1.477	1.173
1200	14.66	2.716	1.205	4.416	0.444	1.467	1.172
1224	15.00	2.705	1.209	4.418	0.447	1.461	1.167



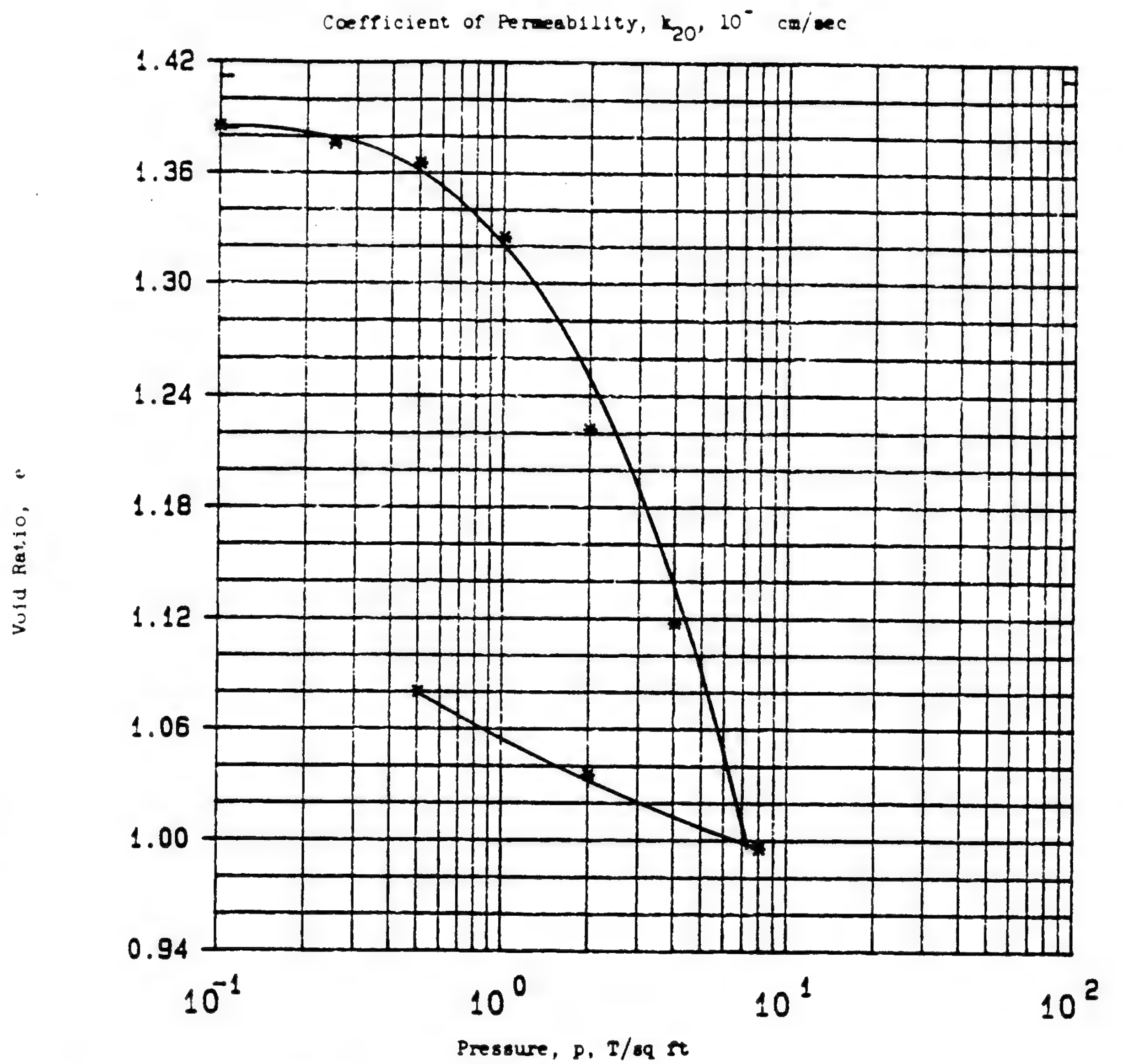
LL - 68	PL - 26	PI - 42	Gs - 2.7	NAT w - %	PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

CLASSIFICATION Fat clay, CH

BORING NO. 89-119 MU
SAMPLE NO. S-3
DEPTH/ELEV 11'-13'
MRD LAB NO. 90/135

GRADATION CURVE

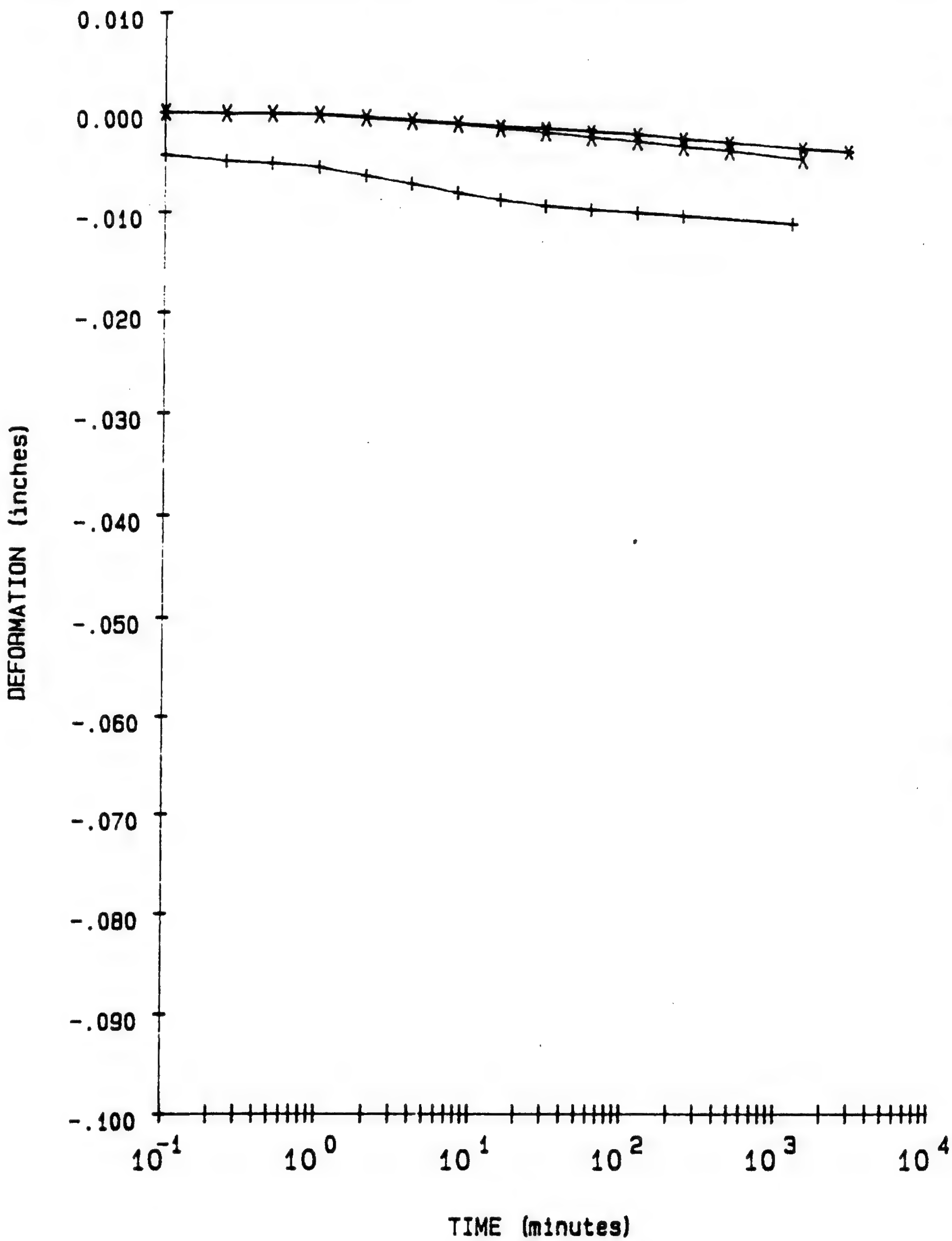
FIGURE 8



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.4 in.	Ht 1 in.	Water Content, w_o	45.5 %	w_f	36.8 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.41	e_f	1.08
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	87 %	S_f	92 %
Compression Index, C_c		Dry Density, γ_d	69.6 lb/ft^3		
Classification Fat clay, CH		k_{20} at e_o = × 10^{-} cm/sec			
LL 69	G_s 2.69	Project	MINNESOTA RIVER; IA-90-04-ED-GH		
PL 23	D_{10}				
Remarks Dark brown. Torvane=0.30 TSF. Torvane=0.30 TSF. Non-calcareous.		Area	MRD LAB NO. 90/135		
		Boring No.	89-119MU	Sample No.	S-4
		Depth El	17.0'-19	Date	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

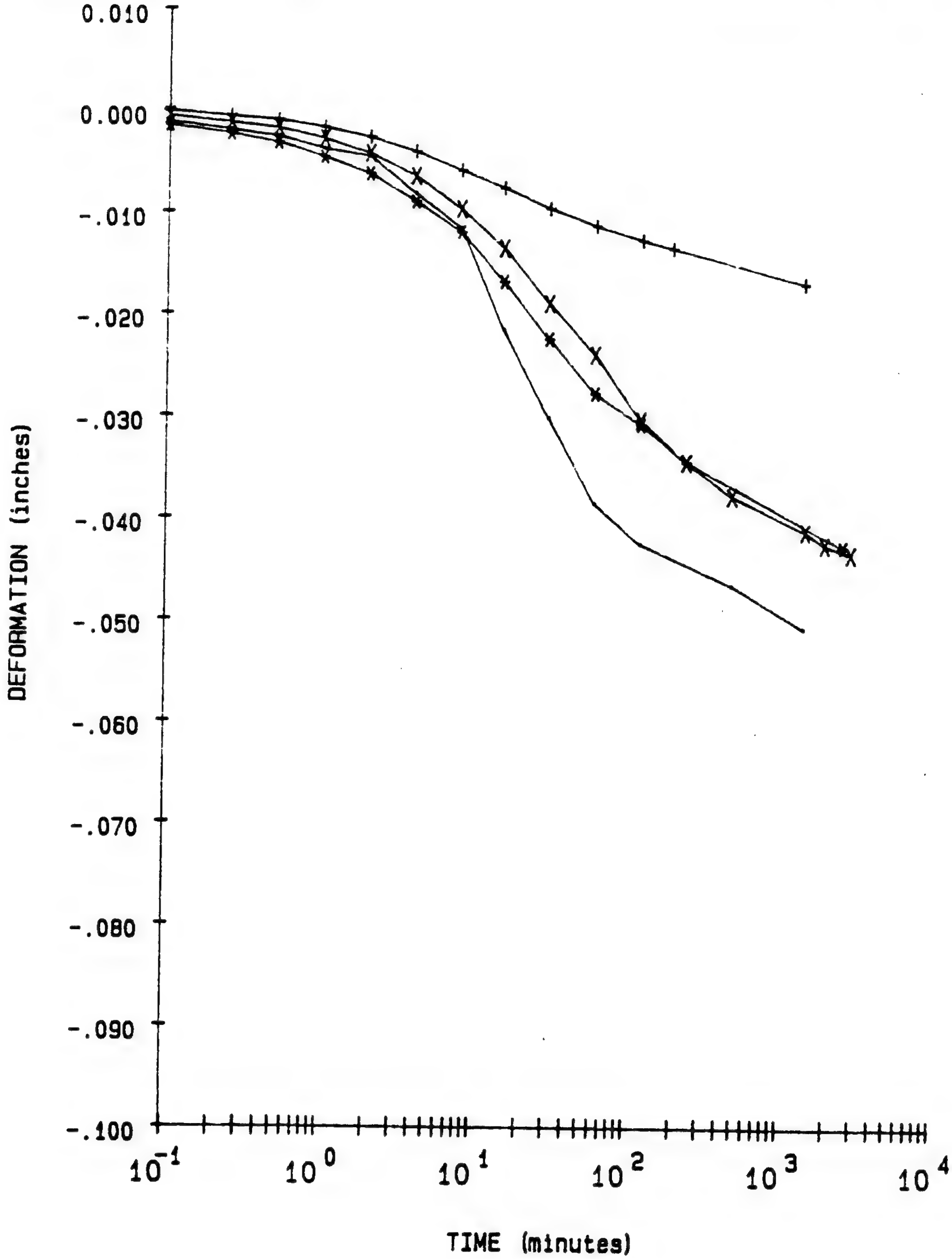
Figure 9



LEGEND	
+ = .1 TSF	
* = .25 TSF	
X = .5 TSF	

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-119MU
SAMPLE NO.	S-4
DEPTH/ELEV	17.0'-19.0'
MRD LAB NO.	90/135

FIGURE 10

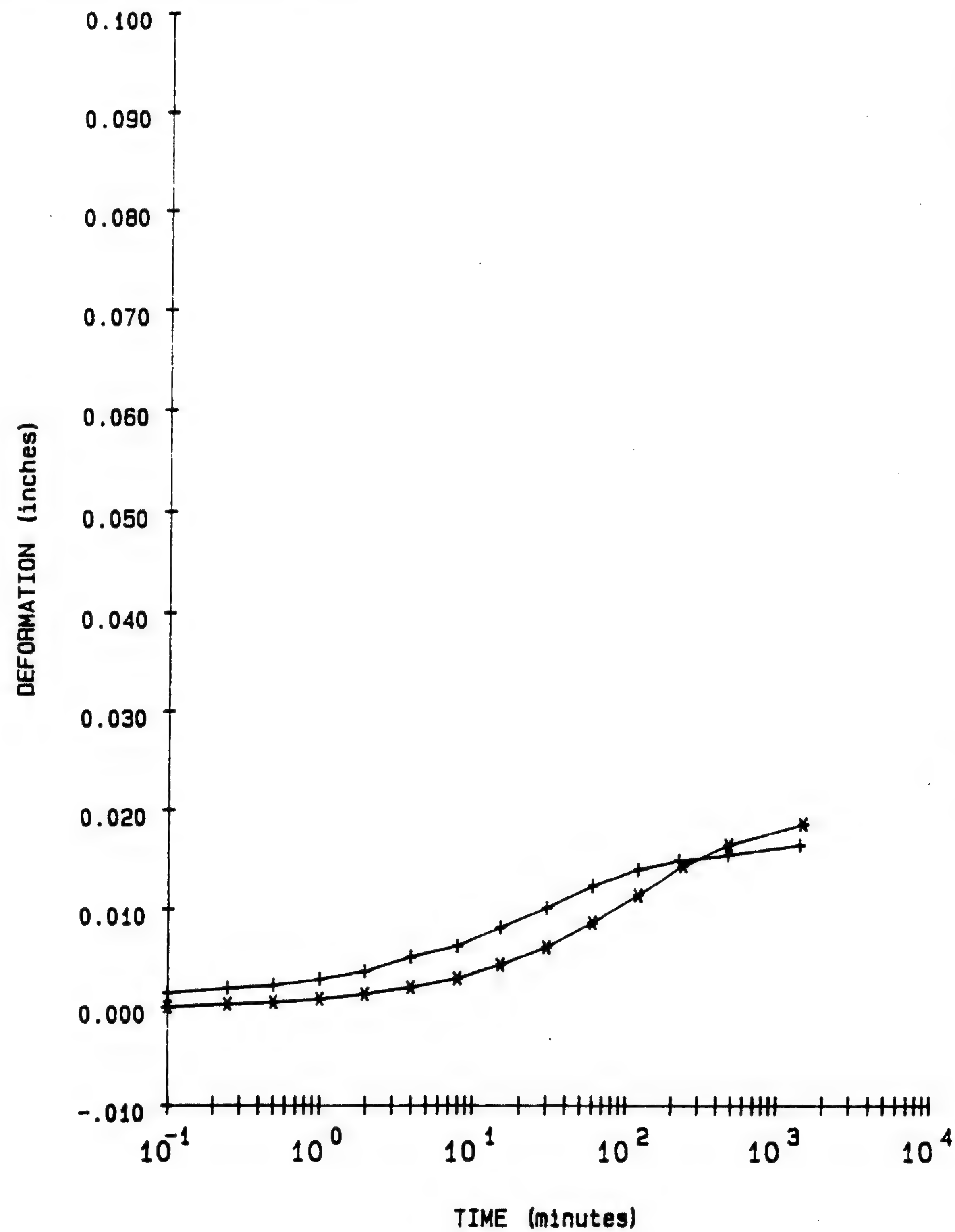


LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF
\- = 8 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-119MU
SAMPLE NO.	S-4
DEPTH/ELEV	17.0'-19.0'
MRD LAB NO.	90/135

FIGURE 11



LEGEND	
+ = 2 TSF Rebound	
* = .5 TSF Rebound	

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-119MU
SAMPLE NO.	S-4
DEPTH/ELEV	17.0'-19.0'
MRD LAB NO.	90/135

FIGURE 12

Consolidation Test Data

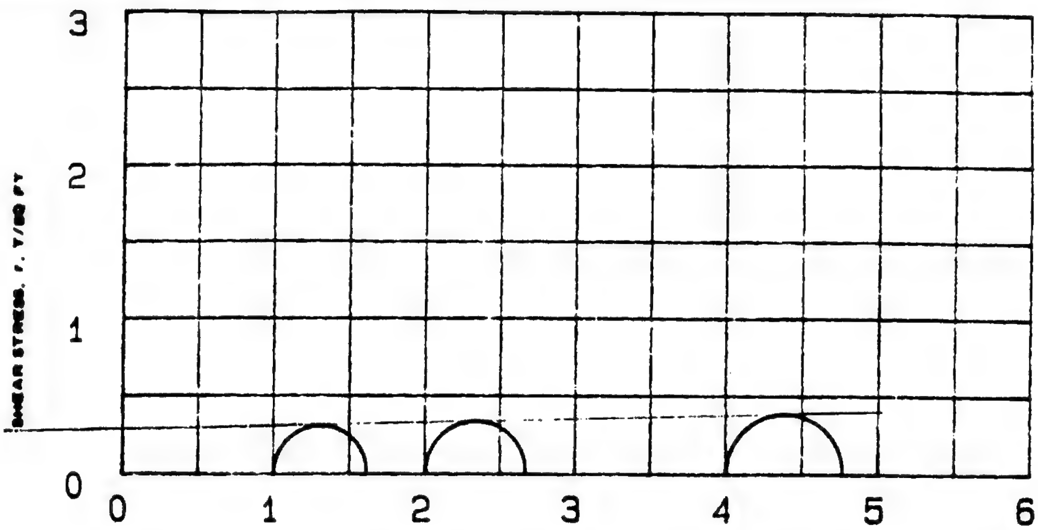
Project MINNESOTA RIVER; IA-90-04-ED-GH

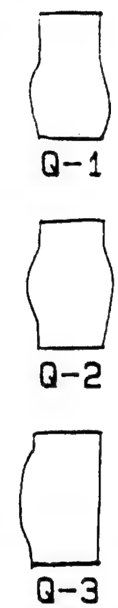
Boring No. 89-119MU
Sample No. S-4
Depth/Elev 17.0'-19.0'
MRD Lab No. 90/135

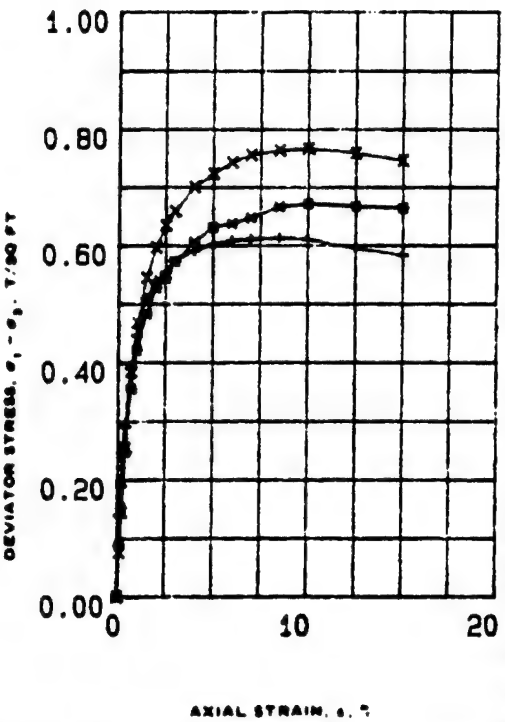
Gs = 2.69
eo = 1.412
0.42eo = 0.593

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
45.5	282.7	69.6	1.412		86.6
36.8	282.7	70.4	1.385	0.10	71.5
36.8	282.7	70.6	1.376	0.25	72.0
36.8	282.7	71.0	1.365	0.50	72.6
36.8	282.7	72.2	1.325	1.00	74.8
36.8	282.7	75.5	1.222	2.00	81.1
36.8	282.7	79.3	1.117	4.00	88.6
36.8	282.7	84.1	0.995	8.00	99.5
36.8	282.7	82.5	1.035	2.00	95.7
36.8	282.7	80.7	1.080	0.50	91.7

Axial Strain (%)	Void Ratio
1	1.388
2	1.364
3	1.340
4	1.316
5	1.291
6	1.267
7	1.243
8	1.219
9	1.195
10	1.171
11	1.147
12	1.123
13	1.098
14	1.074
15	1.050
16	1.026
17	1.002
18	0.978
19	0.954
20	0.930







SPECIMEN NO.			1 (+)	2 (*)	3 (V)	
INITIAL	WATER CONTENT, %	w_o	44.7	41.0	40.8	
	DRY DENSITY LB/CU FT	γ_{d_o}	75.9	78.8	78.6	
	SATURATION, %	S_o	99.0	97.0	96.0	
	VOID RATIO	e_o	1.21	1.13	1.14	
BEFORE SHEAR	WATER CONTENT, %	w_c	44.7	40.8	40.6	
	DRY DENSITY LB/CU FT	γ_{d_c}	75.9	79.0	79.1	
	SATURATION, %	S_c	99.0	98.0	97.0	
	VOID RATIO	e_c	1.21	1.12	1.12	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.0	2.0	4.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.61	0.67	0.77	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	18.0	21.5	21.8	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.58	0.66	0.75	
INITIAL DIAMETER, IN.		D_o	1.40	1.40	1.40	
INITIAL HEIGHT, IN.		H_o	2.99	2.99	2.96	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay. CH

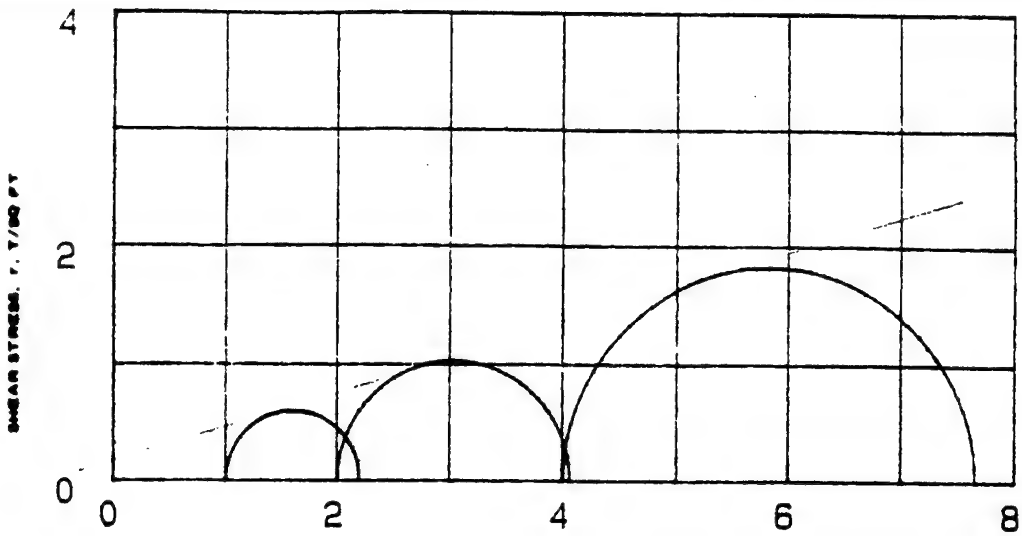
LL 69	PL 23	PI 46	G_s 2.69

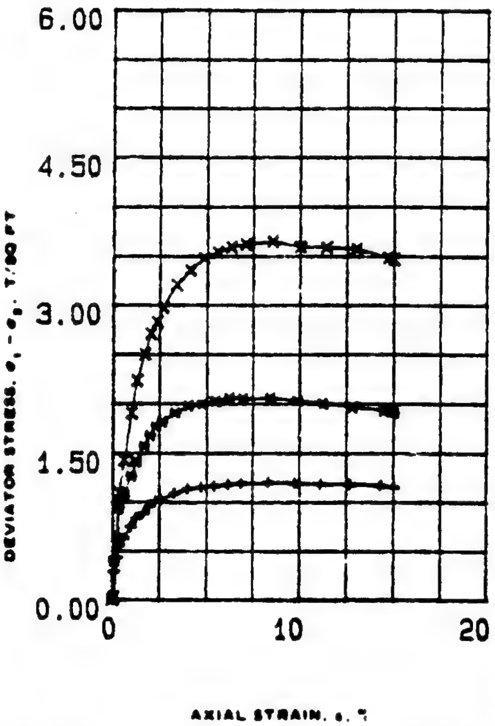
REMARKS: Dark brown. Torvane=0.30TSF.
Non-calcareous.

TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	Q
PROJECT	MINNESOTA RIVER; IA-90-04-ED-6H		
BORING NO	89-119 MU	SAMPLE NO.	S-4
DEPTH ELEV	17'-19'		
LABORATORY	90/135	DATE	

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 13





SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	48.6	45.4	45.7	
	DRY DENSITY LB/CU FT	γ_{d_o}	72.6	74.7	75	
	SATURATION, %	S_o	100	98	99	
	VOID RATIO	e_o	1.31	1.25	1.24	
BEFORE SHEAR	WATER CONTENT, %	w_c	47.7	41.2	37.2	
	DRY DENSITY LB/CU FT	γ_{d_c}	76.2	81.1	84.8	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	1.2	1.07	.98	
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.543	5.543	5.543	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1	2	4	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.200	2.061	3.660	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	720	540	720	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.152	1.915	3.468	
INITIAL DIAMETER, IN.		D_o	1.4	1.43	1.4	
INITIAL HEIGHT, IN.		H_o	2.99	2.99	2.98	

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH B-Value 1.0 1.0 1.0

LL 69	PL 23	PI 46	G_s 2.69	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Dark brown. Torvane=0.30TSF
Non-calcareous.

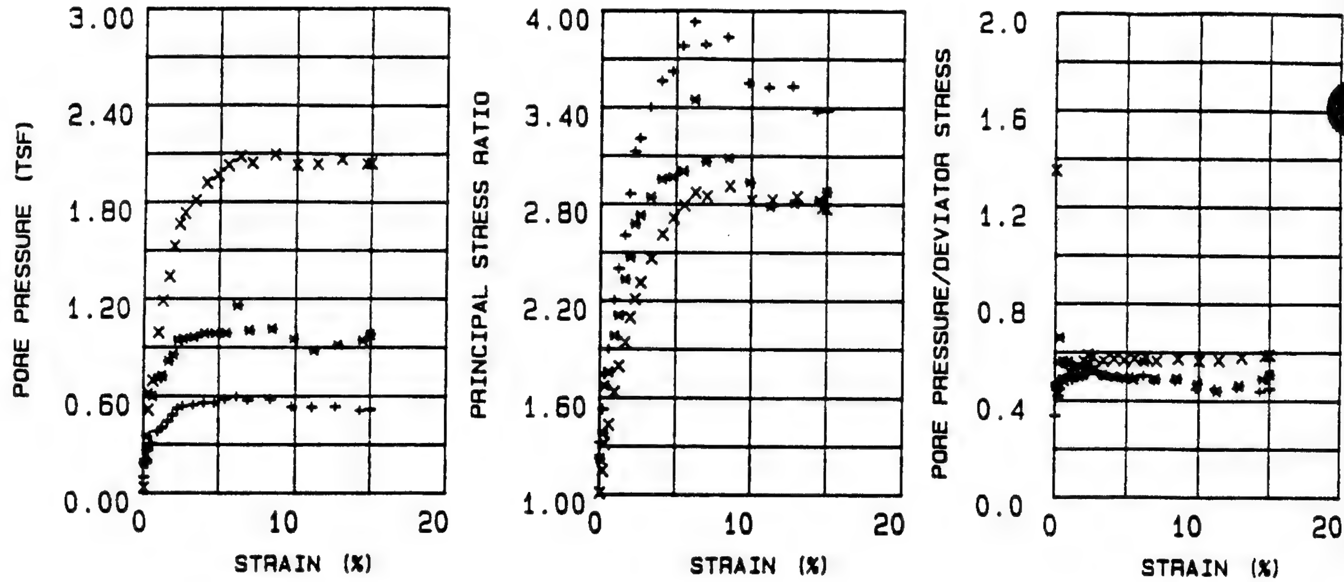
PROJECT MINNESOTA RIVER: IA-90-04-ED-SH

BORING NO 89-119 MU SAMPLE NO. S-4

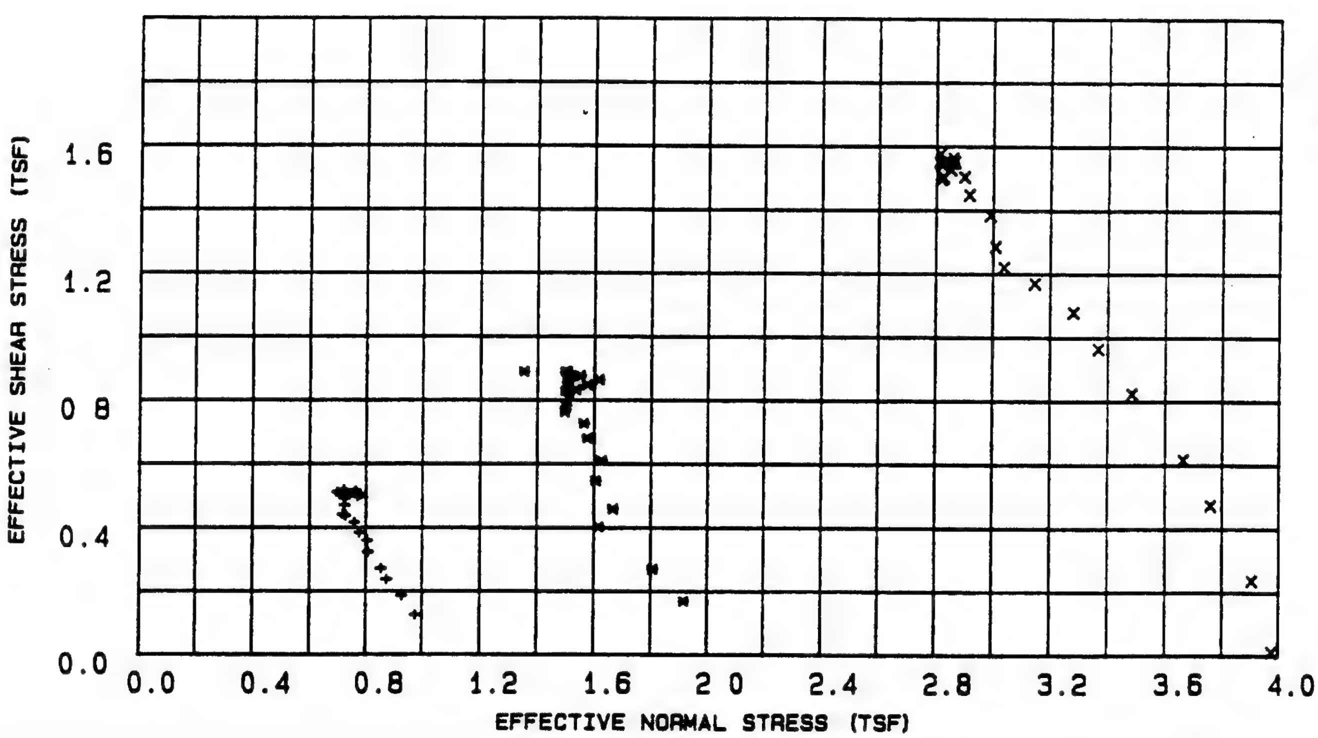
DEPTH ELEV 17'-19'

LABORATORY 90/135 DATE

TRIAXIAL COMPRESSION TEST REPORT



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = 1 TSF

✱ = 2 TSF

X = 4 TSF

PROJECT	MINNESOTA RIVER· IA-90-04-ED-GH
BORING NO.	89-119 MU
SAMPLE NO.	S-4
DEPTH/ELEV	17'-19'
MRD LAB NO.	90/135

FIGURE 15

R

Table 4 - Triaxial $\bar{R}$ Test Results

Project	: MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number	: 89-119 MU
Sample Number	: S-4
Depth	: 17'-19'
Confining Pressure	: 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.288	0.097	1.319	0.337	0.974	0.124
30	0.24	0.432	0.182	1.528	0.421	0.925	0.186
45	0.34	0.549	0.264	1.746	0.480	0.872	0.237
60	0.60	0.627	0.303	1.900	0.484	0.852	0.271
90	0.97	0.748	0.379	2.204	0.507	0.806	0.323
120	1.24	0.834	0.403	2.397	0.484	0.803	0.360
150	1.65	0.889	0.445	2.603	0.501	0.775	0.384
1[illegible]	1.96	0.964	0.482	2.861	0.500	0.757	0.416
2[illegible]	2.28	1.012	0.524	3.124	0.518	0.726	0.437
240	2.61	1.023	0.537	3.207	0.525	0.716	0.441
300	3.29	1.088	0.546	3.400	0.503	0.723	0.470
360	4.00	1.135	0.557	3.563	0.491	0.724	0.490
420	4.70	1.155	0.559	3.620	0.485	0.727	0.498
480	5.40	1.165	0.581	3.780	0.499	0.707	0.503
540	6.13	1.183	0.596	3.929	0.504	0.697	0.511
600	6.88	1.192	0.572	3.787	0.481	0.723	0.515
720	8.36	1.200	0.577	3.835	0.481	0.720	0.518
840	9.76	1.193	0.532	3.551	0.447	0.763	0.515
960	11.12	1.185	0.530	3.524	0.448	0.763	0.512
1080	12.69	1.180	0.533	3.530	0.452	0.759	0.509
1200	14.31	1.165	0.509	3.372	0.437	0.780	0.503
1252	15.00	1.152	0.516	3.382	0.449	0.769	0.497

Table 5 - Triaxial $\bar{R}$ Test Results

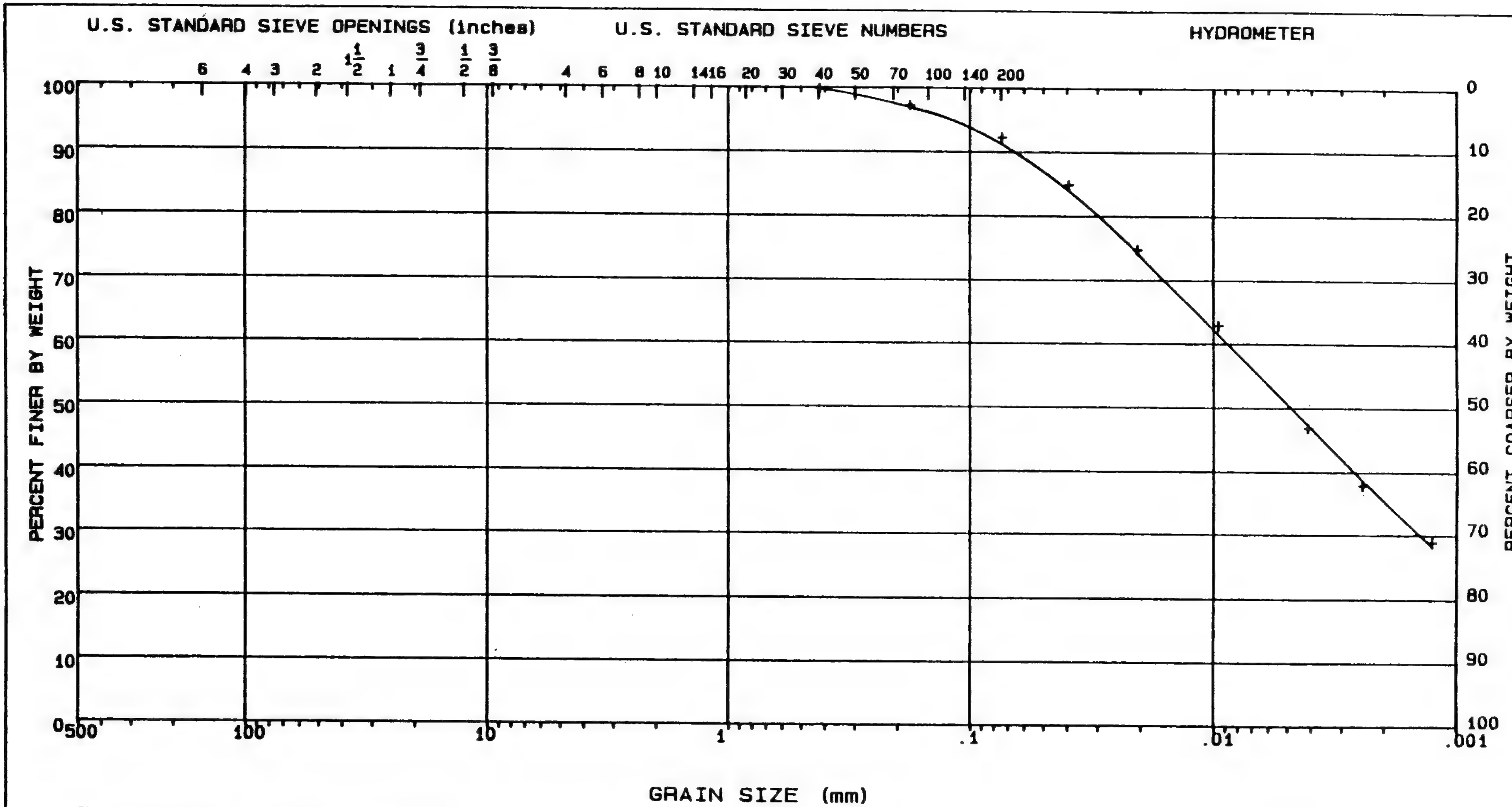
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-119 MU
Sample Number : S-4
Depth : 17'-19'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.395	0.181	1.217	0.459	1.917	0.170
30	0.24	0.625	0.348	1.378	0.556	1.807	0.270
45	0.34	0.934	0.615	1.674	0.660	1.616	0.403
60	0.61	1.064	0.596	1.758	0.561	1.667	0.459
90	0.98	1.268	0.709	1.982	0.560	1.605	0.547
120	1.25	1.415	0.724	2.109	0.512	1.626	0.611
150	1.67	1.577	0.816	2.332	0.518	1.575	0.681
180	1.99	1.683	0.855	2.470	0.508	1.562	0.727
210	2.30	1.770	0.943	2.675	0.534	1.495	0.764
240	2.65	1.817	0.951	2.731	0.524	1.499	0.784
300	3.33	1.910	0.963	2.841	0.505	1.510	0.824
360	4.05	1.982	0.986	2.954	0.498	1.505	0.855
420	4.76	1.997	0.986	2.969	0.494	1.508	0.862
480	5.47	2.029	0.988	3.005	0.487	1.514	0.876
5[illegible]	6.20	2.061	1.158	3.448	0.562	1.352	0.889
6[illegible]	6.96	2.054	1.004	3.062	0.489	1.505	0.887
720	8.46	2.059	1.013	3.085	0.492	1.497	0.889
840	9.88	2.030	0.951	2.934	0.469	1.551	0.876
960	11.25	2.001	0.878	2.783	0.439	1.617	0.864
1080	12.85	1.965	0.912	2.806	0.464	1.575	0.848
1200	14.49	1.927	0.943	2.824	0.490	1.534	0.832
1238	15.00	1.915	0.978	2.877	0.511	1.497	0.827

Table 6 - Triaxial $\overline{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-119 MU
Sample Number : S-4
Depth : 17'-19'
Confining Pressure : 4 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.023	0.030	1.006	1.350	3.976	0.010
30	0.25	0.550	0.232	1.146	0.423	3.904	0.237
45	0.35	1.095	0.513	1.314	0.469	3.758	0.473
60	0.62	1.428	0.692	1.432	0.485	3.662	0.616
90	0.99	1.906	0.989	1.633	0.519	3.483	0.823
120	1.27	2.234	1.186	1.794	0.531	3.367	0.964
150	1.69	2.499	1.338	1.939	0.536	3.281	1.079
180	2.01	2.710	1.525	2.095	0.563	3.146	1.170
210	2.33	2.827	1.662	2.209	0.588	3.038	1.220
240	2.68	2.979	1.730	2.312	0.581	3.008	1.286
300	3.38	3.206	1.806	2.461	0.564	2.988	1.384
360	4.10	3.356	1.916	2.610	0.572	2.915	1.448
420	4.82	3.484	1.966	2.713	0.565	2.897	1.504
480	5.54	3.539	2.026	2.793	0.573	2.850	1.527
[illegible]	6.29	3.591	2.080	2.870	0.580	2.809	1.550
6	7.06	3.623	2.038	2.847	0.563	2.859	1.564
720	8.57	3.650	2.091	2.912	0.573	2.813	1.576
840	10.01	3.593	2.026	2.821	0.564	2.864	1.551
960	11.40	3.588	2.034	2.825	0.567	2.854	1.549
1080	13.02	3.570	2.065	2.844	0.579	2.819	1.541
1200	14.68	3.482	2.038	2.774	0.586	2.824	1.503
1223	15.00	3.468	2.042	2.771	0.590	2.816	1.497



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

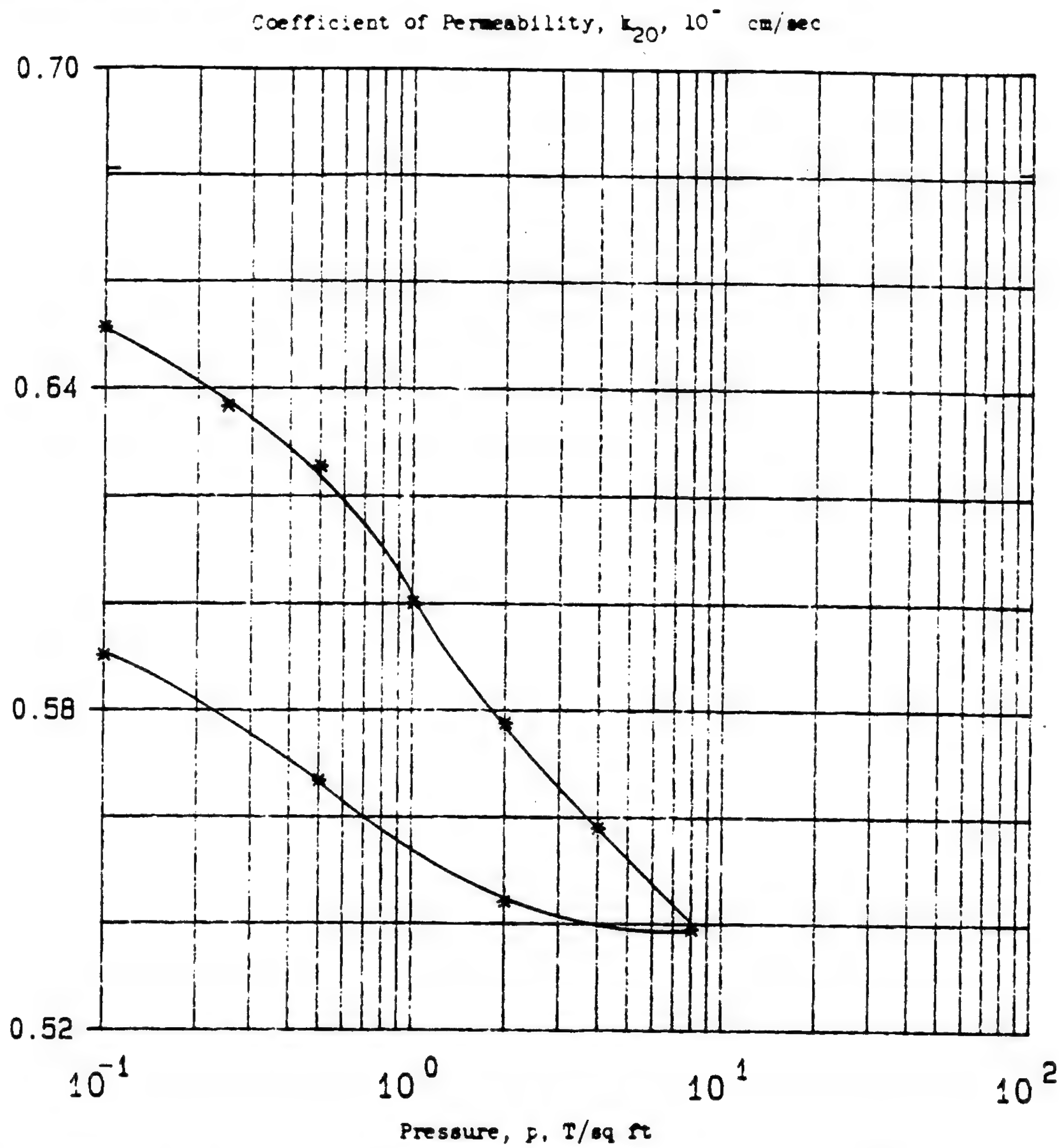
LL = 69	PL = 23	PI = 46	Gs = 2.69	NAT w = %

CLASSIFICATION Fat clay, CH

GRADATION CURVE

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-119 MU
SAMPLE NO.	S-4
DEPTH/ELEV	30'-32'
MRD LAB NO.	90/135

FIGURE 16

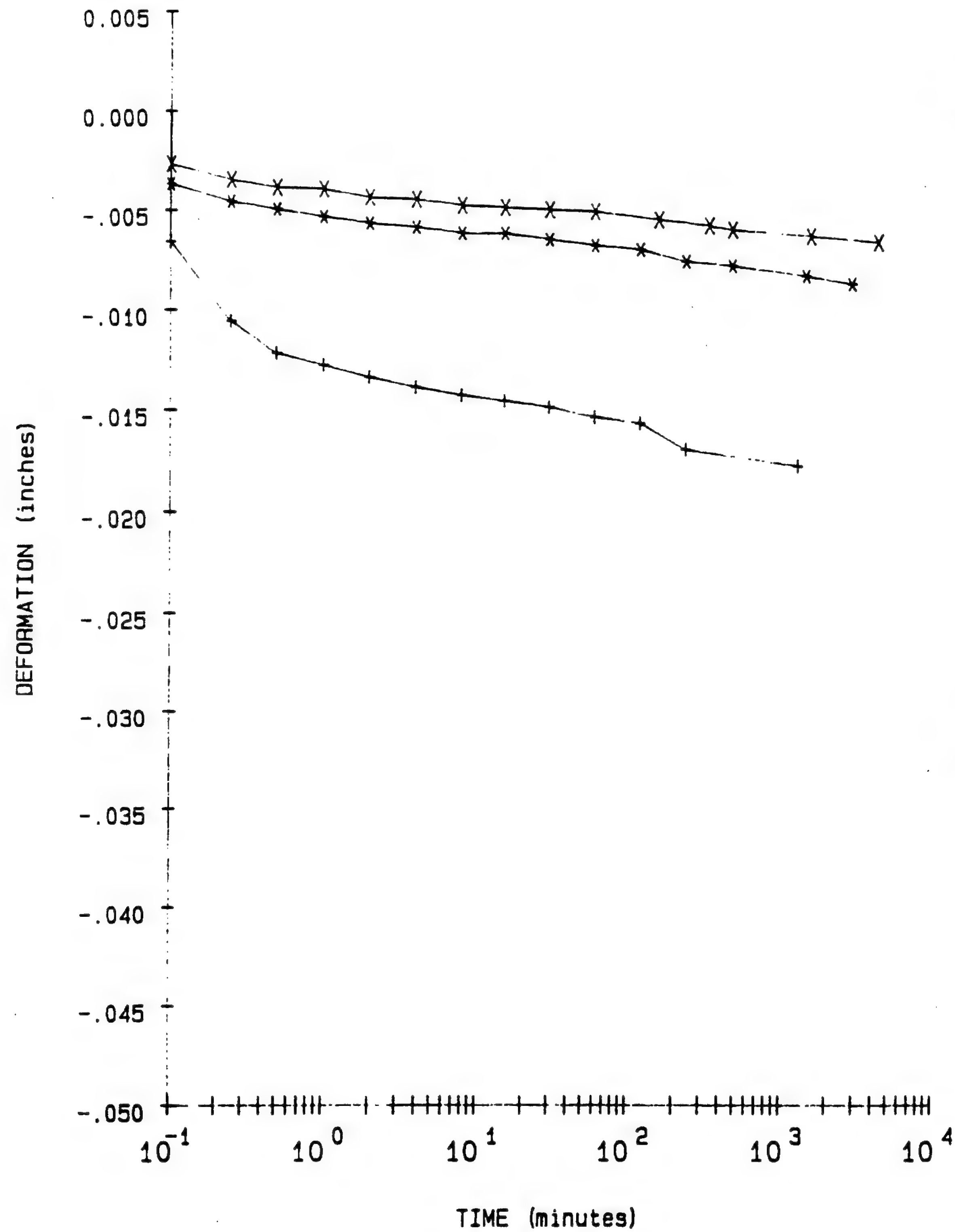


Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.3 in.	Ht 1 in.	Water Content, w_o	25.7 %	w_f	23.9 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	0.68	e_f	0.59
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	100 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	100.6 lb/ft^3		
Classification Clayey Silt CL-ML		k_{20} at e_o = × 10^{-} cm/sec			
LL 27	G_s 2.71	Project MINNESOTA RIVER: IA-90-04-FD-GH			
PL 20	D_{10}				
Remarks Mottled gray, rust.		Area MRD LAB NO. 90/135			
Torvane=0.45 TSF. Slightly		Boring No. 89-119 MU		Sample No. S-5	
calcareous.		Depth El 27.5'-29.5'		Date	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 1

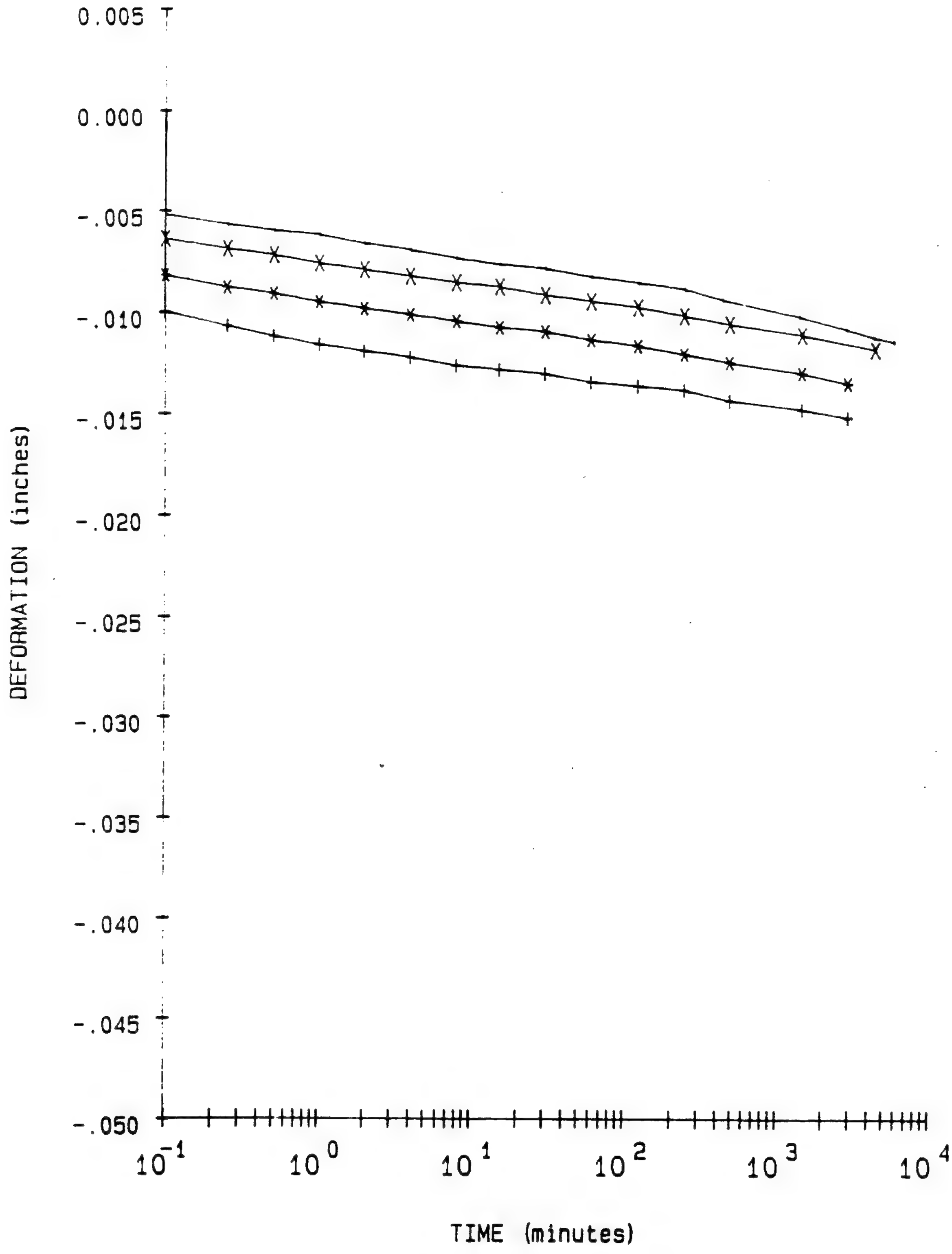
Figure C-441



LEGEND	
+ = .1 TSF	
* = .25 TSF	
X = .5 TSF	

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-119 MU
SAMPLE NO.	S-5
DEPTH/ELEV	27.5'-29.5'
MRD LAB NO.	90/135

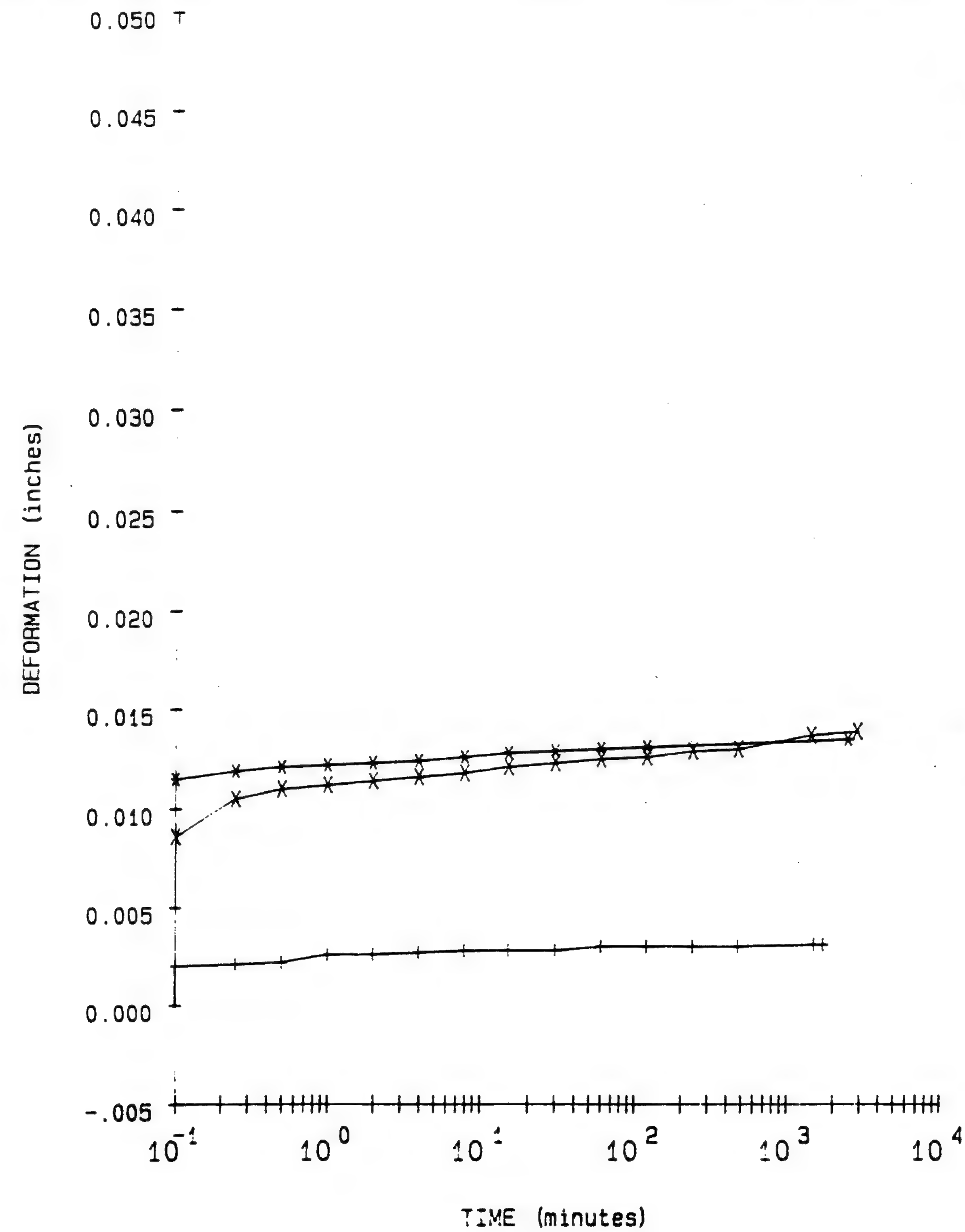
FIGURE 2



LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-119 MU
SAMPLE NO.	S-5
DEPTH/ELEV	27.5'-29.5'
MRD LAB NO.	90/135

FIGURE 3



LEGEND

+ = 2 TSF Rebound
✱ = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-119 MU
SAMPLE NO.	S-5
DEPTH/ELEV	27.5'-29.5'
MRD LAB NO.	90/135

FIGURE 4

Consolidation Test Data

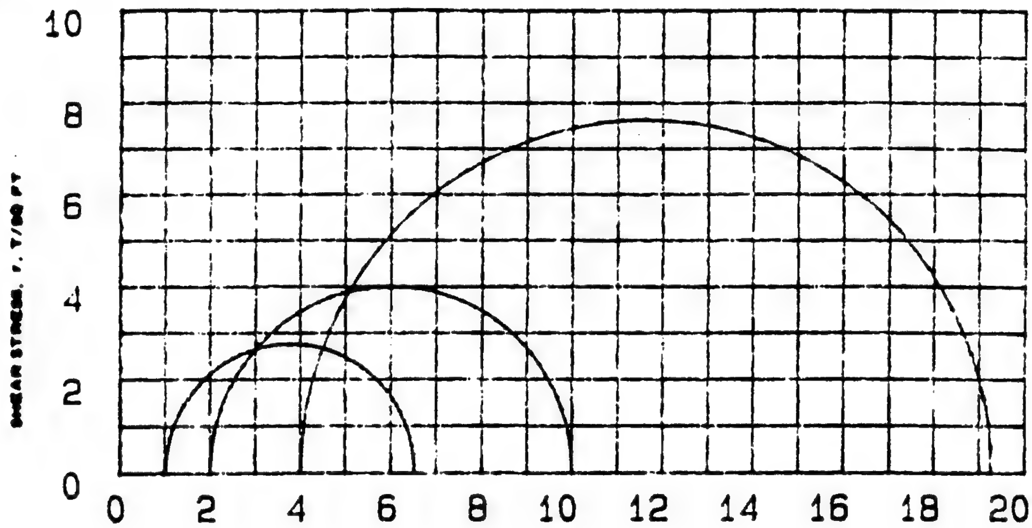
Project MINNESOTA RIVER; IA-90-04-ED-GH

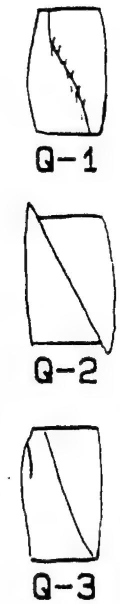
Boring No. 89-119 MU
Sample No. S-5
Depth/Elev 27.5'-29.5'
MRD Lab No. 90/135

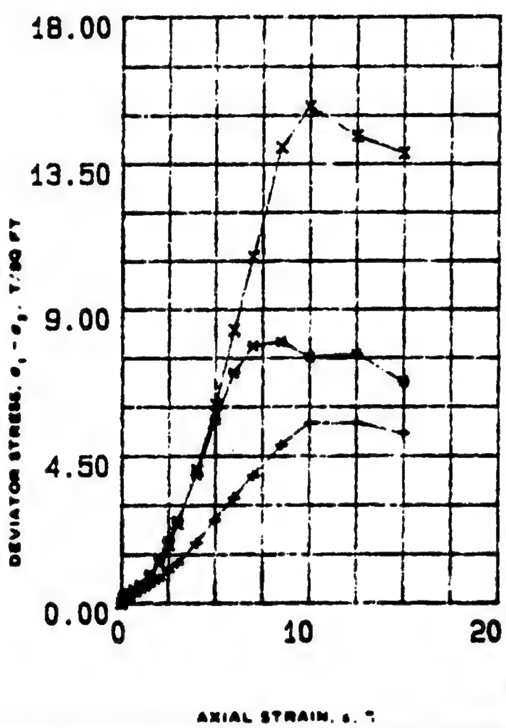
Gs = 2.71
eo = 0.681
0.42eo = 0.286

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
25.7	378.1	100.6	0.681		100.0
23.9	378.1	102.4	0.651	0.10	99.2
23.9	378.1	103.3	0.637	0.25	100.0
23.9	378.1	104.0	0.625	0.50	100.0
23.9	378.1	105.7	0.600	1.00	100.0
23.9	378.1	107.2	0.578	2.00	100.0
23.9	378.1	108.5	0.558	4.00	100.0
3.9	378.1	109.9	0.539	8.00	100.0
23.9	378.1	109.5	0.544	2.00	100.0
23.9	378.1	107.9	0.567	0.50	100.0
23.9	378.1	106.3	0.590	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.664
2	0.648
3	0.631
4	0.614
5	0.597
6	0.580
7	0.563
8	0.547
9	0.530
10	0.513
11	0.496







SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	24.8	23.0	22.2
	DRY DENSITY LB/CU FT	γ_{d_o}	103.1	107.0	109.1
	SATURATION, %	S_o	100.0	100.0	100.0
	VOID RATIO	e_o	0.64	0.58	0.55
BEFORE SHEAR	WATER CONTENT, %	w_c	25.0	23.0	22.2
	DRY DENSITY LB/CU FT	γ_{d_c}	103.1	107.0	109.1
	SATURATION, %	S_c	100.0	100.0	100.0
	VOID RATIO	e_c	0.64	0.58	0.55
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.0	2.0	4.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	5.51	8.00	15.28
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_1	24.3	20.0	25.3
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	5.17	6.75	13.82
INITIAL DIAMETER, IN.		D_o	1.40	1.40	1.40
INITIAL HEIGHT, IN.		H_o	2.98	2.98	2.98

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Clayey Silt CL-ML

LL 27 | PL 20 | PI 7 | G_s 2.71

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST Q

REMARKS: Mottled gray, rust. Torvane= 0.45 TSF. Slightly calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

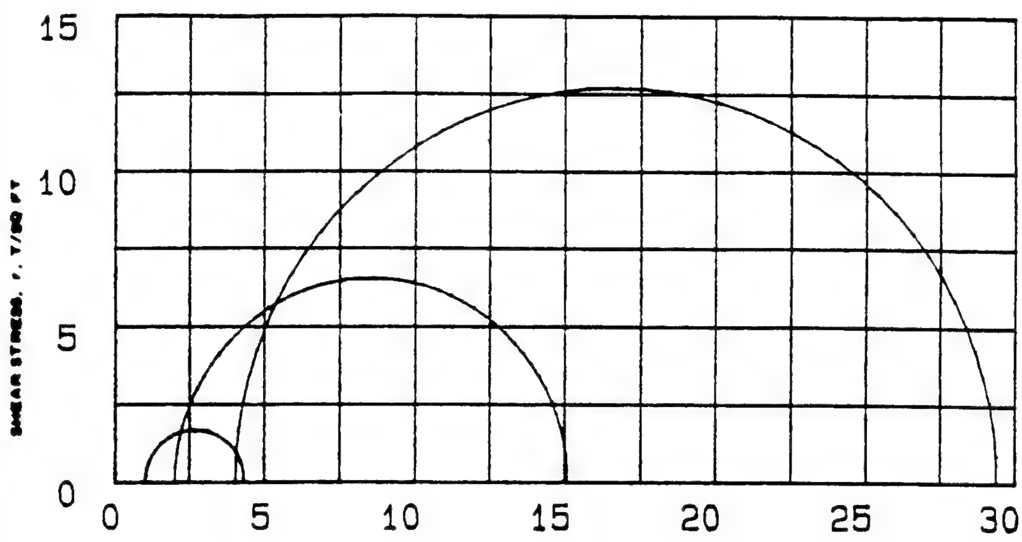
BORING NO 89-119 MU | SAMPLE NO. S-5

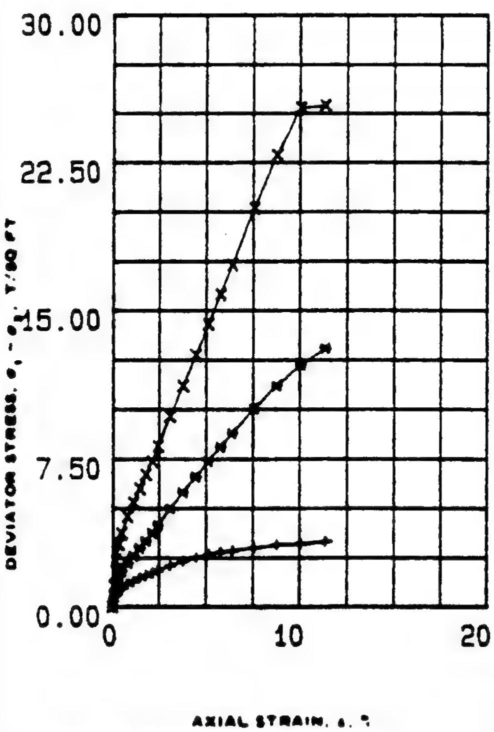
DEPTH ELEV 27.5'-29.5'

LABORATORY 90/135 | DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 5





NORMAL STRESS, σ, T/SQ FT

SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_0	25.6	28.1	25.4
	DRY DENSITY LB/CU FT	γ_{d_0}	101.1	100.5	102.4
	SATURATION, %	S_0	100	100	100
	VOID RATIO	e_0	.67	.68	.65
BEFORE SHEAR	WATER CONTENT, %	w_c	24.4	24.5	23.6
	DRY DENSITY LB/CU FT	γ_{d_c}	101.9	101.5	103.6
	SATURATION, %	S_c	100	100	100
	VOID RATIO	e_c	.66	.67	.63
	FINAL BACK PRESSURE, T/SQ FT	u_0	4.103	4.103	4.103
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1	2	4
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	3.319	13.079	25.386
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1080	1080	1080
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	3.319	13.079	25.386
INITIAL DIAMETER, IN.		D_0	1.4	1.41	1.41
INITIAL HEIGHT, IN.		H_0	2.94	2.96	2.96

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Clayey Silt CL-ML

LL 27	PL 20	PI 7	G_s 2.71

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST RBAR

REMARKS: Mottled gray, rust. Torvane= 0.45 TSF. Slightly calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

BORING NO 89-119MU | SAMPLE NO. S-5

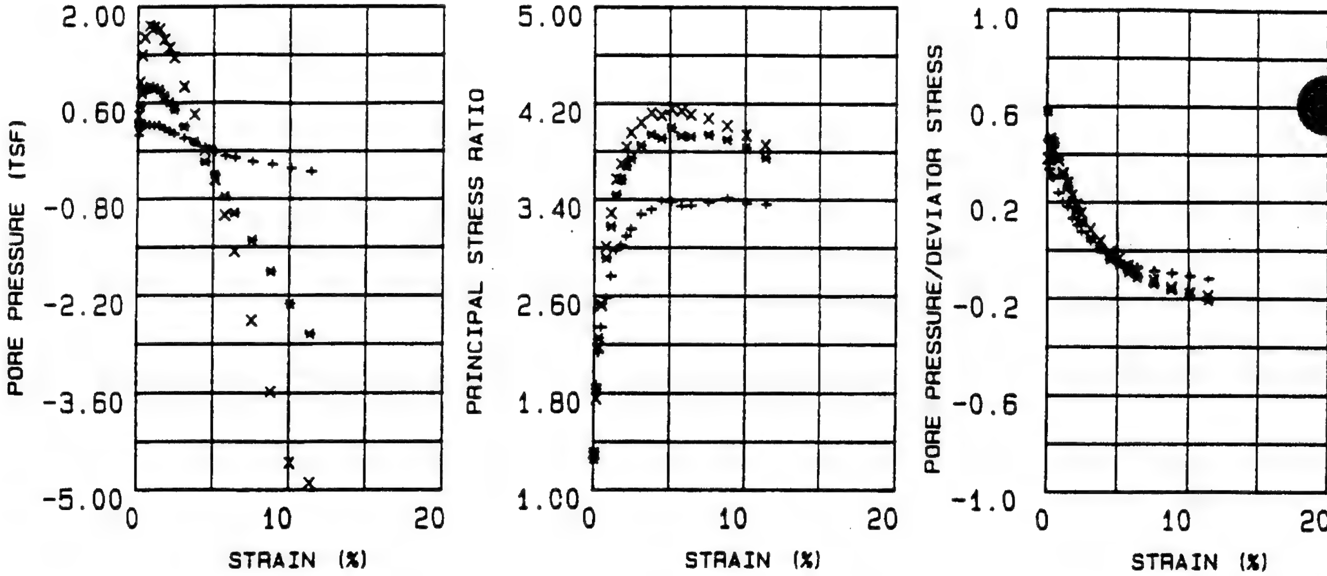
DEPTH ELEV 27.5'-29.5'

LABORATORY 90/135 | DATE

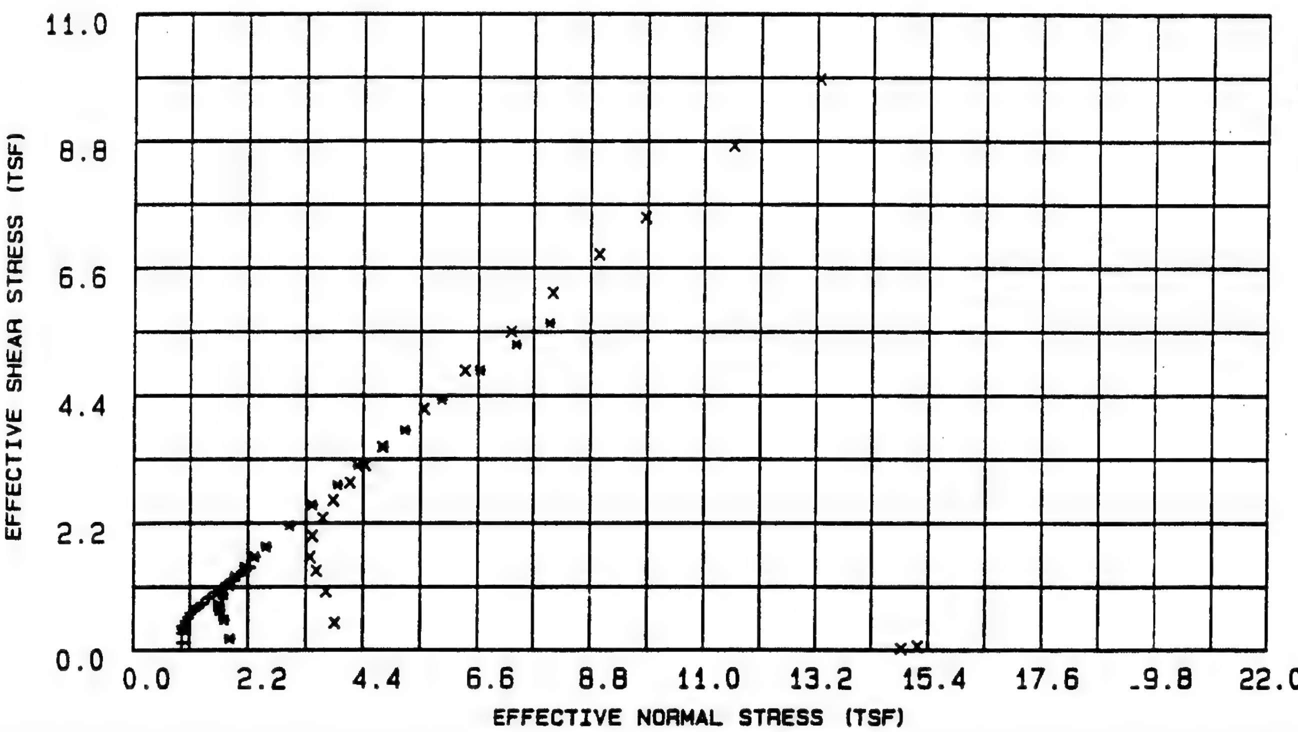
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 6



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND	
+ = 1	TSF
✱ = 2	TSF
X = 4	TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-119MU
SAMPLE NO.	S-5
DEPTH/ELEV	27.5'-29.5'
MRD LAB NO.	90/135

FIGURE 7

R

Table 3 - Triaxial $\overline{R}$ Test Results

Project	:	MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number	:	89-119MU
Sample Number	:	S-5
Depth	:	27.5'-29.5'
Confining Pressure	:	1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.272	0.123	1.311	0.453	0.944	0.118
30	0.19	0.670	0.225	1.864	0.336	0.941	0.289
45	0.34	0.844	0.257	2.136	0.305	0.952	0.364
60	0.51	0.956	0.286	2.339	0.299	0.951	0.413
90	0.83	1.153	0.271	2.582	0.236	1.014	0.498
120	1.14	1.304	0.260	2.761	0.200	1.063	0.563
150	1.48	1.463	0.260	2.976	0.178	1.102	0.631
180	1.80	1.595	0.209	3.016	0.131	1.186	0.688
210	2.14	1.725	0.175	3.092	0.102	1.252	0.745
240	2.45	1.855	0.138	3.152	0.075	1.321	0.801
300	3.11	2.103	0.075	3.275	0.036	1.446	0.908
360	3.79	2.321	-0.003	3.315	-0.001	1.578	1.002
420	4.47	2.511	-0.054	3.383	-0.021	1.676	1.084
4[illegible]	5.13	2.672	-0.123	3.379	-0.046	1.785	1.153
5[illegible]	5.78	2.773	-0.184	3.342	-0.066	1.871	1.197
600	6.41	2.840	-0.210	3.347	-0.074	1.913	1.226
720	7.58	3.015	-0.270	3.375	-0.089	2.016	1.301
840	8.82	3.149	-0.307	3.409	-0.097	2.087	1.359
960	10.08	3.213	-0.358	3.366	-0.111	2.153	1.387
1080	11.39	3.319	-0.408	3.358	-0.122	2.230	1.432

Table 2 - Triaxial $\bar{R}$ Test Results

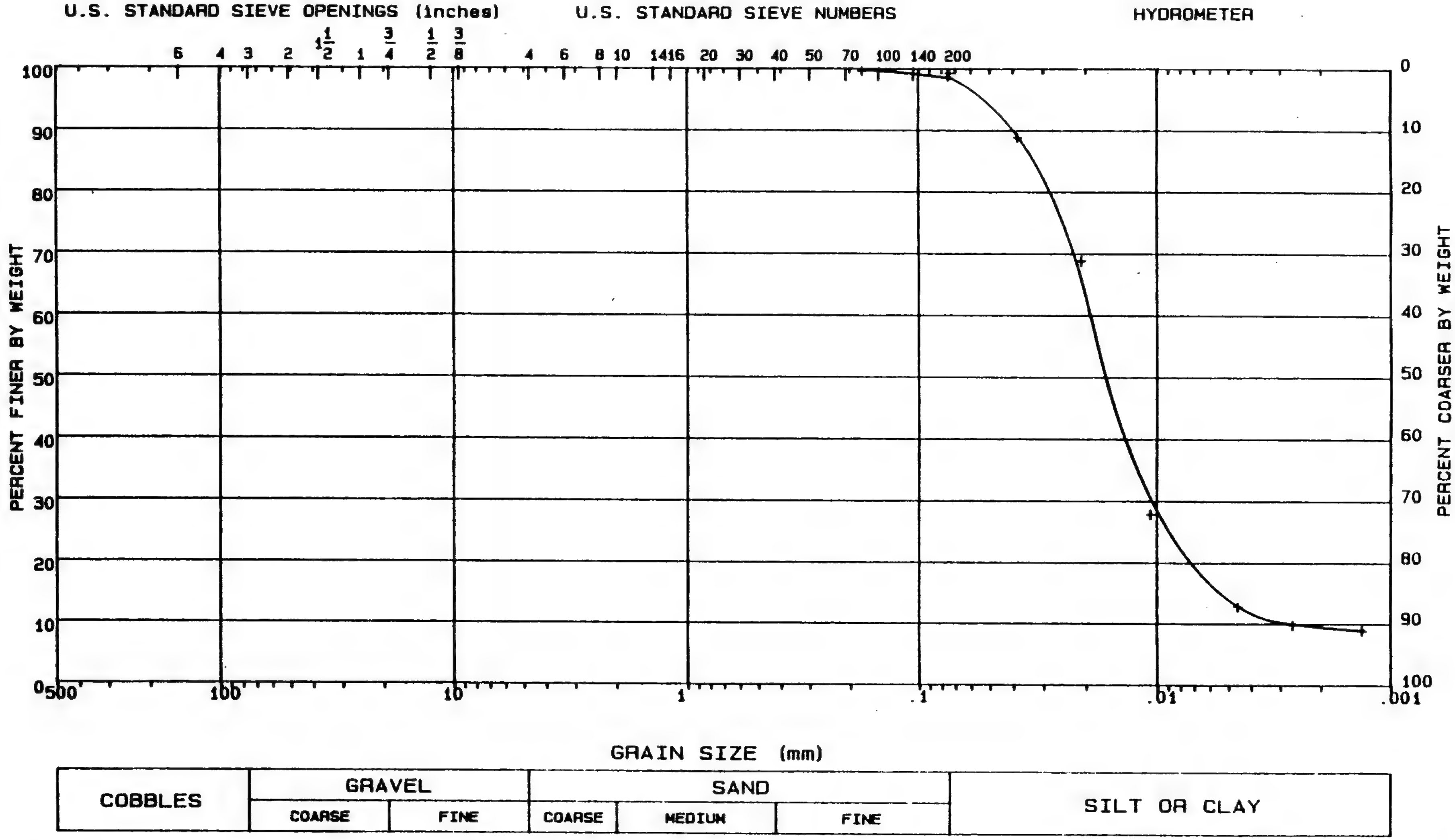
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-119MU
Sample Number : S-5
Depth : 27.5'-29.5'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.444	0.258	1.255	0.580	1.852	0.192
30	0.19	1.202	0.555	1.832	0.462	1.743	0.519
45	0.34	1.579	0.736	2.249	0.467	1.655	0.681
60	0.51	1.820	0.811	2.532	0.446	1.640	0.786
90	0.83	2.227	0.834	2.910	0.375	1.717	0.961
120	1.14	2.593	0.807	3.174	0.312	1.835	1.119
150	1.48	2.975	0.779	3.436	0.262	1.958	1.284
180	1.79	3.355	0.690	3.562	0.206	2.141	1.448
210	2.13	3.750	0.599	3.677	0.160	2.329	1.618
240	2.44	4.143	0.488	3.741	0.118	2.538	1.788
300	3.10	4.994	0.248	3.850	0.050	2.989	2.156
360	3.78	5.814	0.023	3.940	0.004	3.416	2.509
420	4.46	6.603	-0.272	3.906	-0.041	3.907	2.850
480	5.11	7.382	-0.464	3.996	-0.062	4.292	3.186
5[illegible]	5.77	8.114	-0.773	3.926	-0.095	4.782	3.502
600	6.39	8.802	-1.014	3.921	-0.115	5.193	3.799
720	7.56	10.036	-1.416	3.938	-0.141	5.901	4.332
840	8.79	11.192	-1.866	3.895	-0.166	6.637	4.830
960	10.05	12.240	-2.329	3.828	-0.190	7.359	5.283
1080	11.36	13.079	-2.766	3.744	-0.211	8.004	5.645

Table 1 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-119MU
Sample Number : S-5
Depth : 27.5'-29.5'
Confining Pressure : 4 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	1.079	0.410	1.301	0.380	3.857	0.466
30	0.19	2.342	0.896	1.754	0.383	3.684	1.011
45	0.34	3.185	1.288	2.174	0.405	3.500	1.374
60	0.51	3.730	1.546	2.520	0.415	3.378	1.610
90	0.82	4.576	1.715	3.003	0.375	3.418	1.975
120	1.14	5.280	1.689	3.284	0.320	3.618	2.279
150	1.48	5.994	1.662	3.564	0.278	3.822	2.587
180	1.79	6.705	1.510	3.693	0.226	4.150	2.894
210	2.13	7.392	1.390	3.832	0.189	4.440	3.191
240	2.44	8.128	1.248	3.953	0.154	4.764	3.508
300	3.10	9.648	0.824	4.038	0.086	5.565	4.164
360	3.78	11.178	0.419	4.121	0.038	6.348	4.825
420	4.45	12.735	-0.107	4.101	-0.008	7.260	5.497
480	5.11	14.289	-0.526	4.157	-0.036	8.064	6.167
5[illegible]	5.76	15.820	-1.047	4.135	-0.066	8.964	6.828
600	6.39	17.302	-1.573	4.105	-0.090	9.856	7.467
720	7.55	20.189	-2.571	4.073	-0.127	11.569	8.714
840	8.79	22.869	-3.596	4.011	-0.157	13.258	9.870
960	10.05	25.289	-4.616	3.935	-0.182	14.877	10.915
1080	11.35	25.386	-4.910	3.849	-0.193	15.195	10.957



LL = 27	PL = 20	PI = 7	Gs = 2.71	NAT w = %

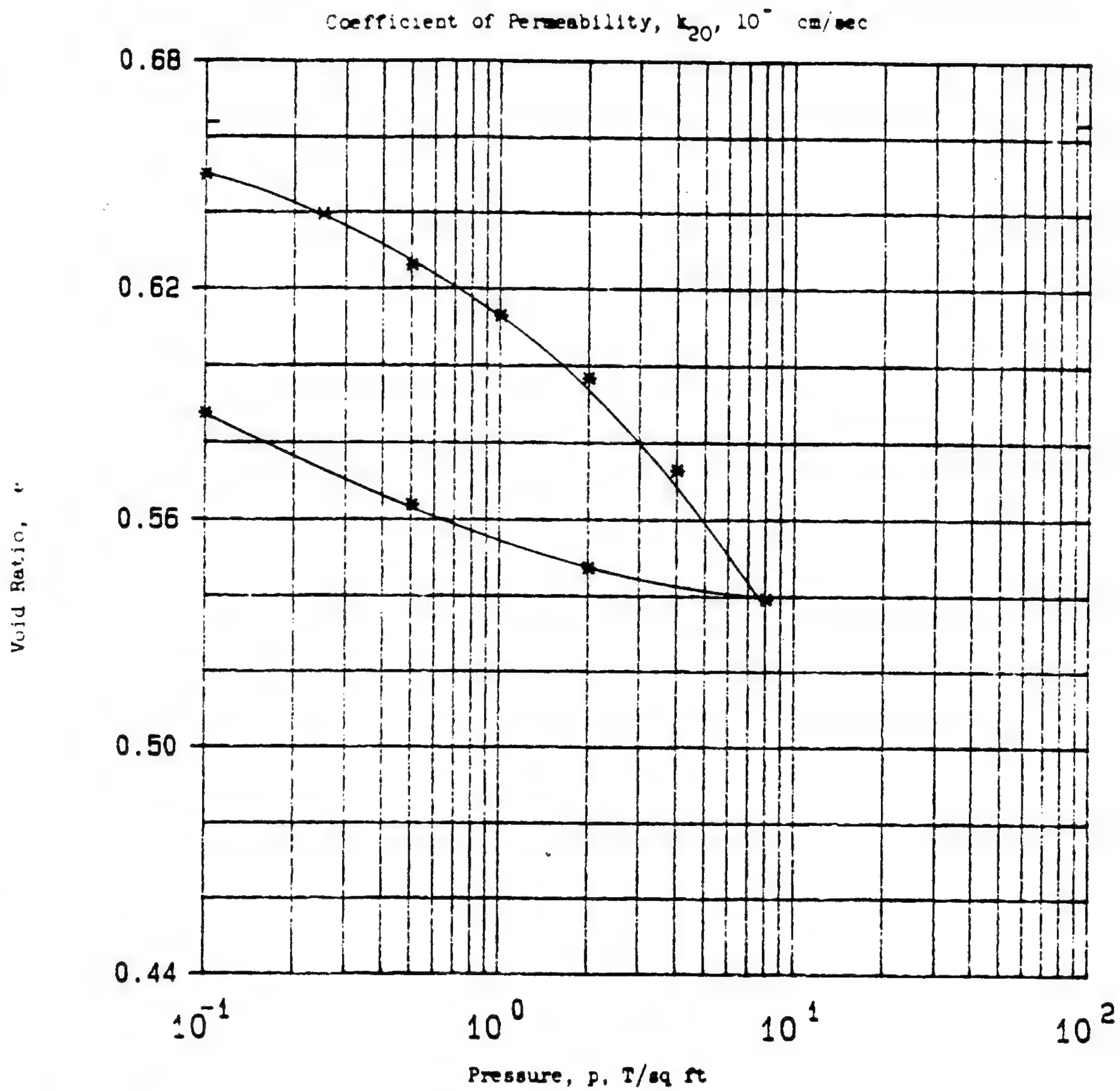
CLASSIFICATION

CLayey Silt CL-ML

GRADATION CURVE

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-119 MU
SAMPLE NO.	S-5
DEPTH/ELEV	27.5'-29.5'
MRD LAB NO.	90/135

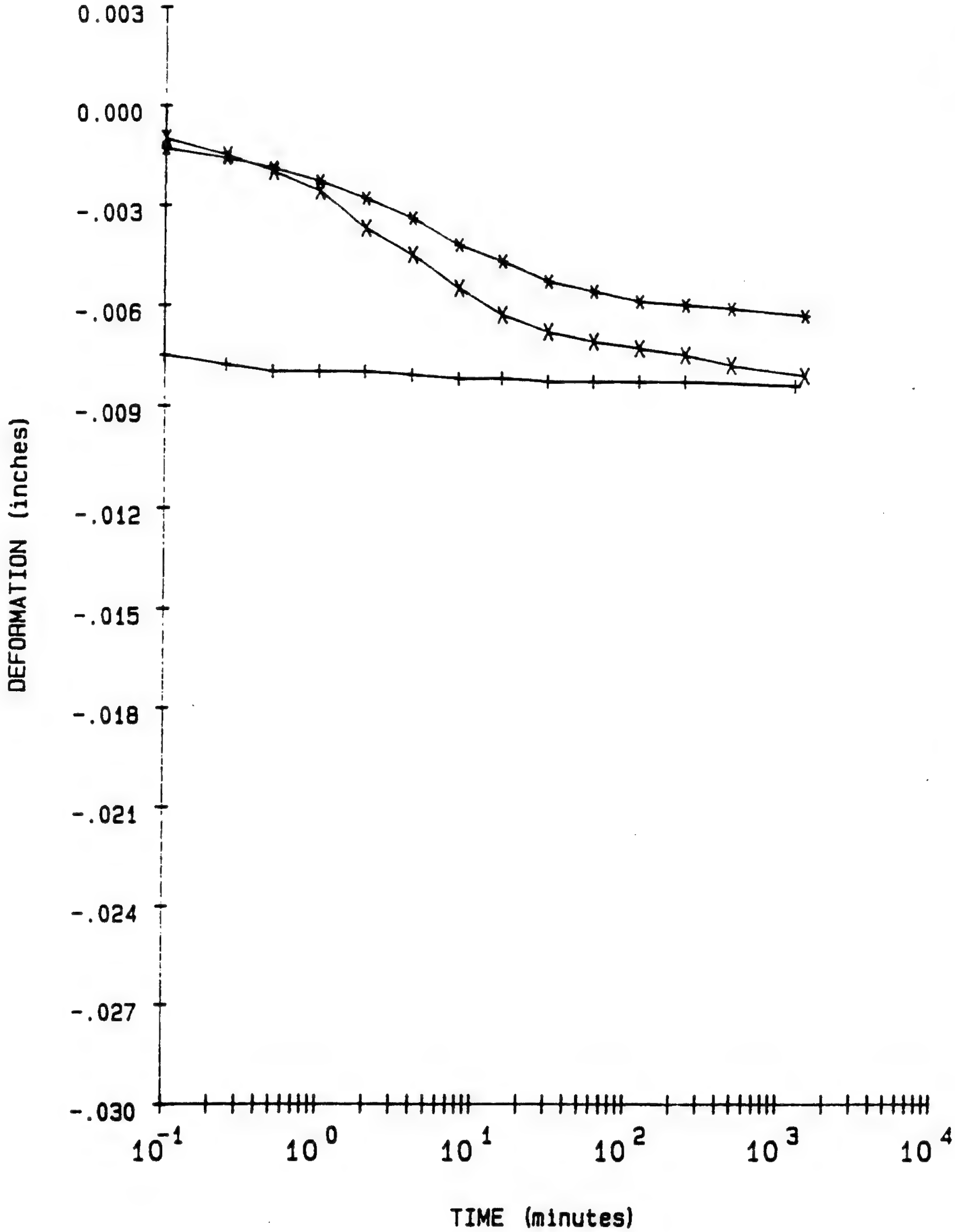
FIGURE 8



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.4 in.	Ht 1 in.	Water Content, w_o	23.8 %	w_f	23.6 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	0.66	e_f	0.59
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	97 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	102.0 lb/ft^3		
Classification Lean clay, CL		k_{20} at e_o = × 10^{-} cm/sec			
LL 33	G_s 2.72	Project	MINNESOTA RIVER: IA-90-04-ED-GH		
PL 16	D_{10}				
Remarks Medium gray. Torvane=0.80 TSF. Slightly calcareous.		Area	MRD LAB NO. 90/135		
		Boring No. 89-119 MU		Sample No. S-6	
		Depth El 33'-35'		Date	
		CONSOLIDATION TEST REPORT			

ENG FORM 2090 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE.

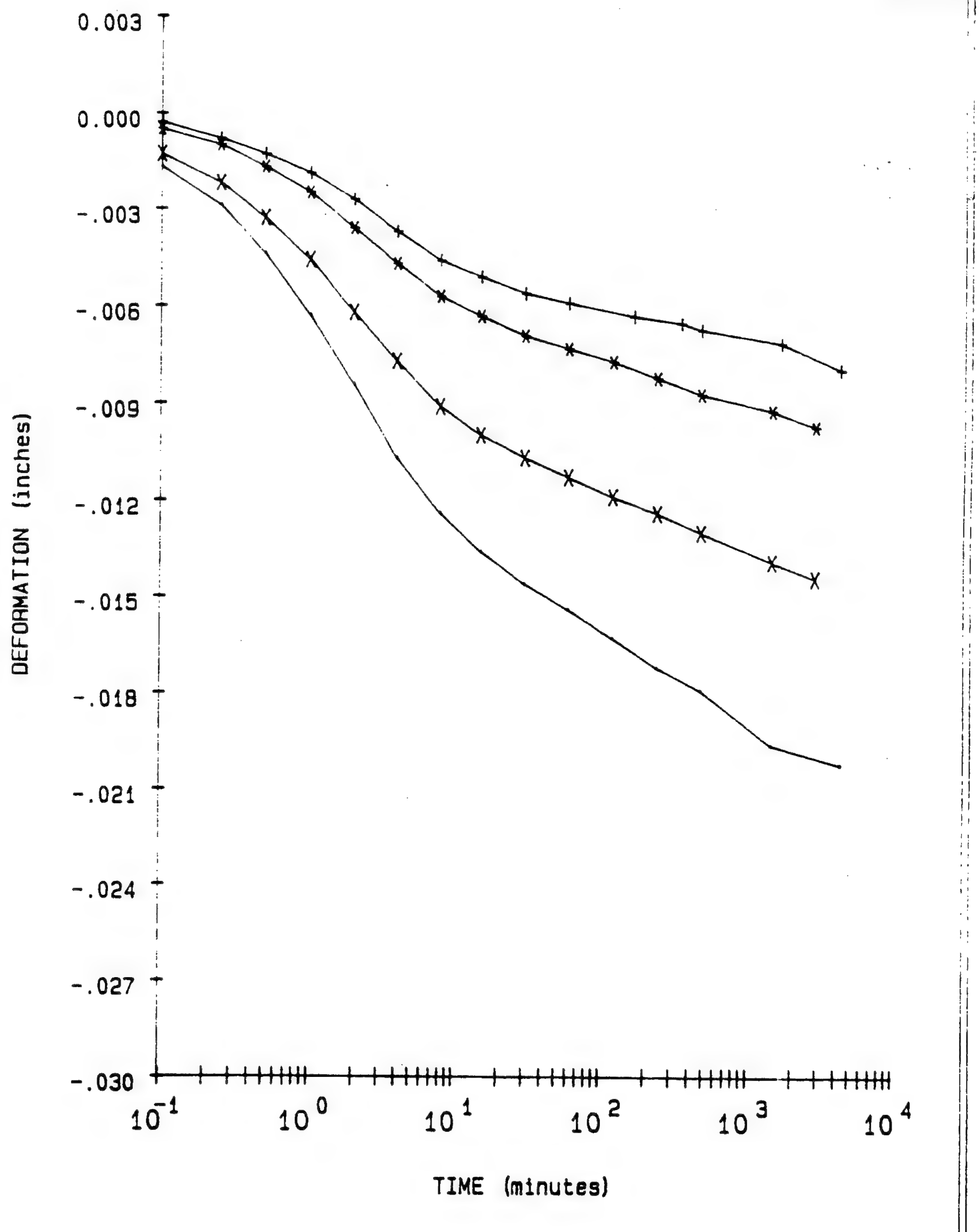
Figure 9



LEGEND
+ = .1 TSF
* = .25 TSF
X = .5 TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-119 MU
SAMPLE NO.	S-6
DEPTH/ELEV	33'-35'
MRD LAB NO.	90/135

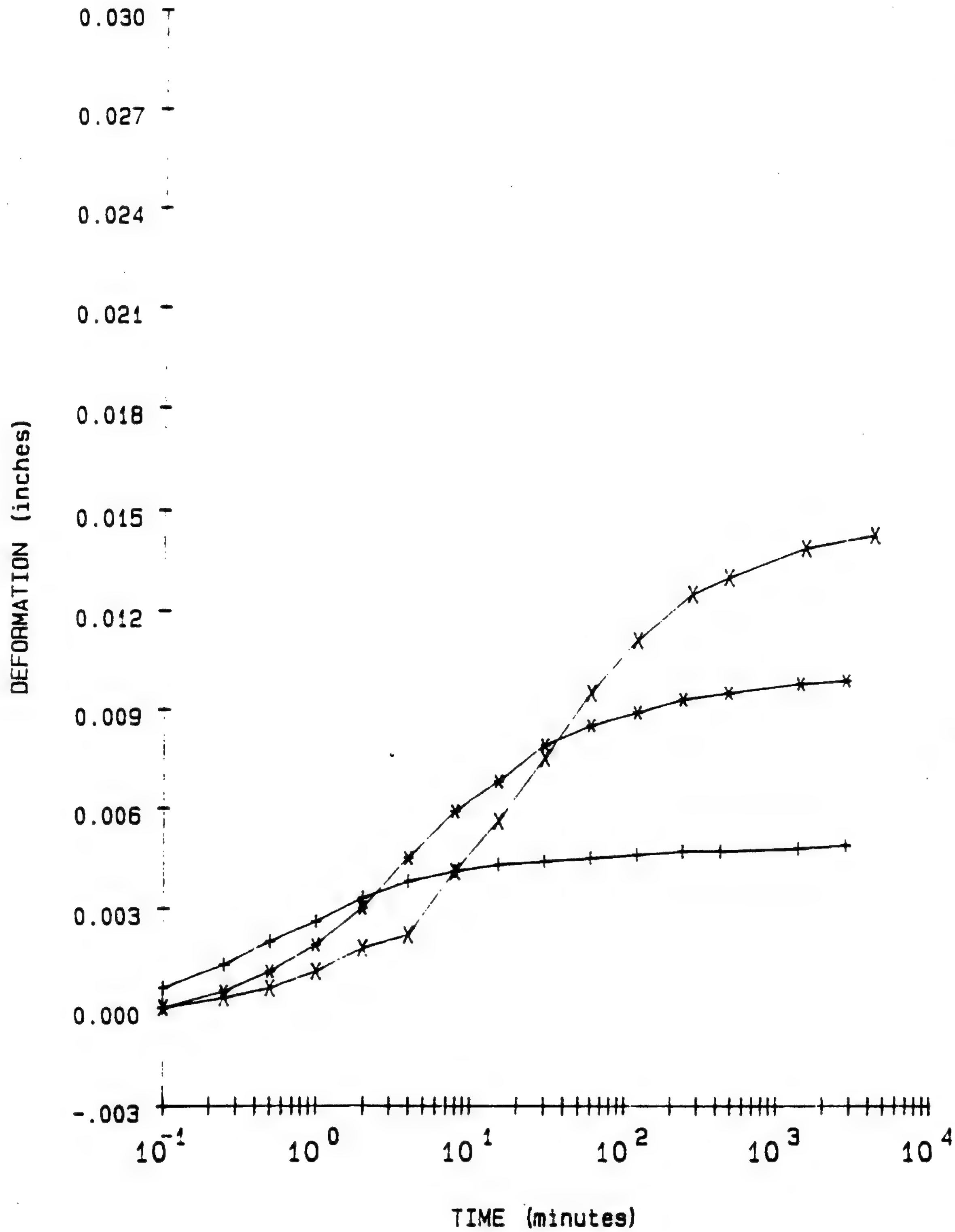
FIGURE 10



LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-119 MU
SAMPLE NO.	S-6
DEPTH/ELEV	33'-35'
MRD LAB NO.	90/135

FIGURE 11



LEGEND

+ = 2 TSF Rebound

* = .5 TSF Rebound

X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-119 MU
SAMPLE NO.	S-6
DEPTH/ELEV	33'-35'
MRD LAB NO.	90/135

FIGURE 12

Consolidation Test Data

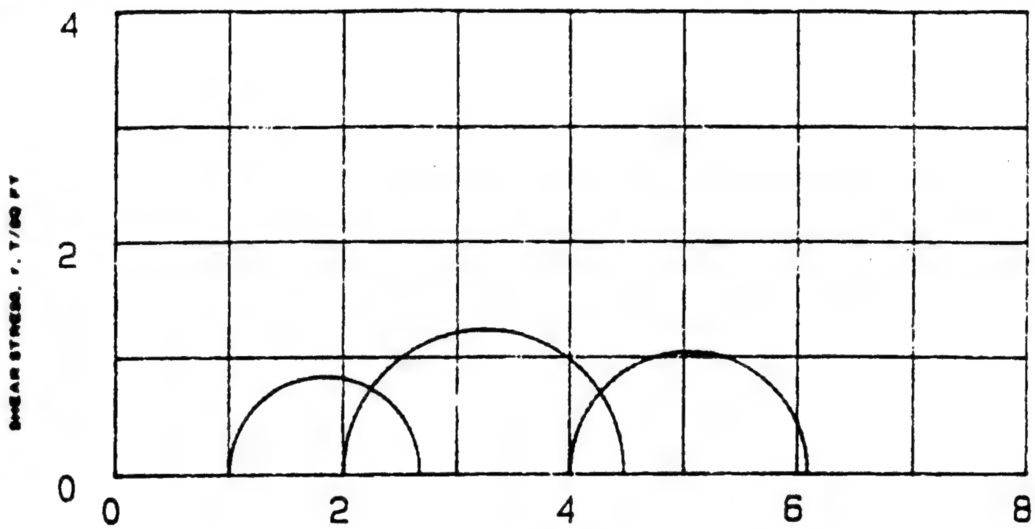
Project MINNESOTA RIVER; IA-90-04-ED-GH

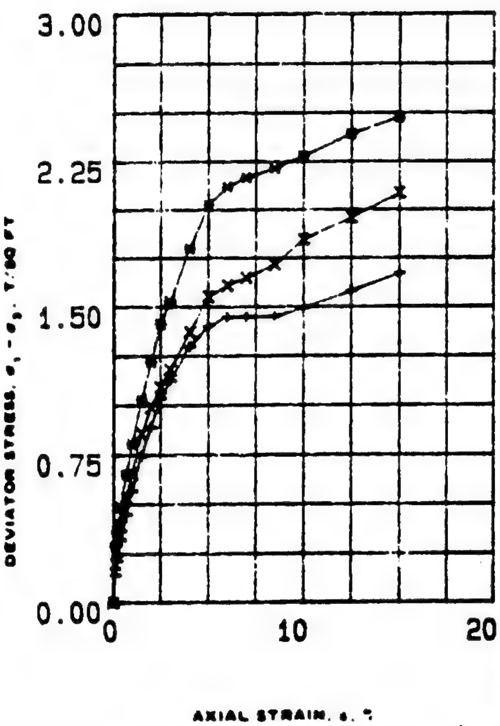
Boring No. 89-119 MU
Sample No. S-6
Depth/Elev 33'-35'
MRD Lab No. 90/135

Gs = 2.72
eo = 0.664
0.42eo = 0.279

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
23.8	414.4	102.0	0.664		97.3
23.6	414.4	102.9	0.650	0.10	98.9
23.6	414.4	103.5	0.639	0.25	100.0
23.6	414.4	104.4	0.626	0.50	100.0
23.6	414.4	105.2	0.613	1.00	100.0
23.6	414.4	106.3	0.597	2.00	100.0
23.6	414.4	107.9	0.573	4.00	100.0
3.6	414.4	110.3	0.539	8.00	100.0
23.6	414.4	109.7	0.547	2.00	100.0
23.6	414.4	108.5	0.564	0.50	100.0
23.6	414.4	106.9	0.588	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.647
2	0.631
3	0.614
4	0.597
5	0.581
6	0.564
7	0.547
8	0.531
9	0.514
10	0.498





			1 (+)	2 (*)	3 (X)	
SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT %	w_o	22.9	23.4	23.6	
	DRY DENSITY LB/CU FT	γ_{d_o}	108.9	109.8	107.3	
	SATURATION, %	S_o	100.0	100.0	100.0	
	VOID RATIO	e_o	0.56	0.55	0.58	
BEFORE SHEAR	WATER CONTENT, %	w_c	22.9	23.4	23.6	
	DRY DENSITY LB/CU FT	γ_{d_c}	108.9	109.8	107.3	
	SATURATION, %	S_c	100.0	100.0	100.0	
	VOID RATIO	e_c	0.56	0.56	0.58	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.0	2.0	4.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.67	2.48	2.09	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	32.5	33.3	32.3	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.67	2.48	2.09	
INITIAL DIAMETER, IN.		D_o	1.40	1.39	1.40	
INITIAL HEIGHT, IN.		H_o	2.99	2.98	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL

LL 33	PL 16	PI 17	G_s 2.72	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Medium gray. Torvane=0.80TSF
Slightly calcareous.

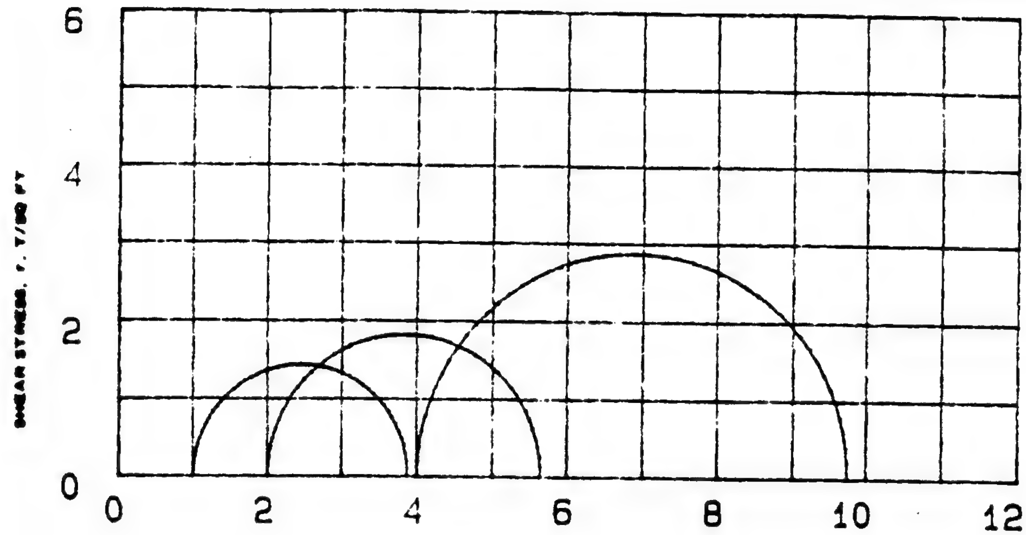
PROJECT MINNESOTA RIVER: IA-90-04-ED-GH

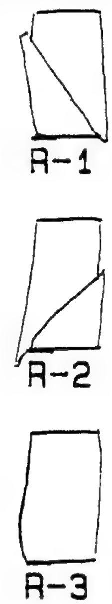
BORING NO 89-119 MU | SAMPLE NO. S-6

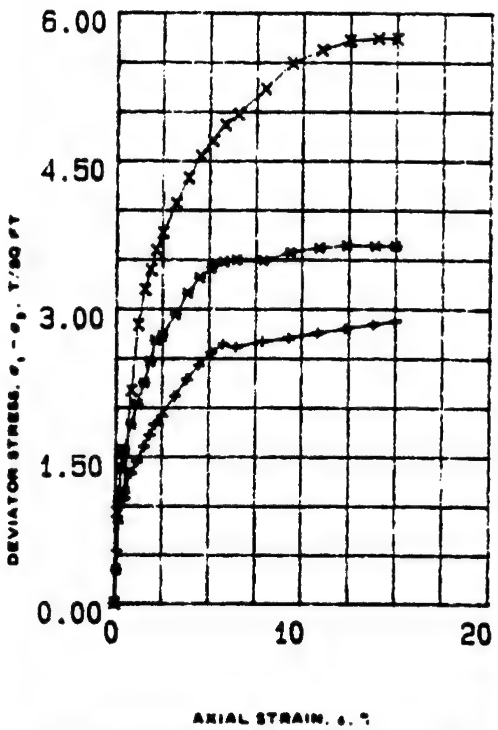
DEPTH ELEV 33'-35'

LABORATORY 90/135 | DATE

TRIAXIAL COMPRESSION TEST REPORT







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	23.4	24.2	23.7	
	DRY DENSITY LB/CU FT	γ_{d_o}	103.5	102.9	103.5	
	SATURATION, %	S_o	100	100	100	
	VOID RATIO	e_o	.84	.85	.84	
BEFORE SHEAR	WATER CONTENT, %	w_c	23	23.3	20.6	
	DRY DENSITY LB/CU FT	γ_{d_c}	104.6	105.9	108.9	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.82	.8	.56	
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.543	5.543	5.543	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1	2	4	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	2.876	3.650	5.746	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1299	1080	1200	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	2.876	3.843	5.741	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.4	
INITIAL HEIGHT, IN.		H_o	2.99	2.98	2.99	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL B-Value 1.0 1.0 1.0

LL 33	PL 16	PI 17	G_s 2.72	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST R-BAR

REMARKS: Medium gray. Torvane=0.80TSF.
Slightly calcareous.

PROJECT MINNESOTA RIVER: IA-90-04-ED-6H

BORING NO 89-119 MU SAMPLE NO. S-6

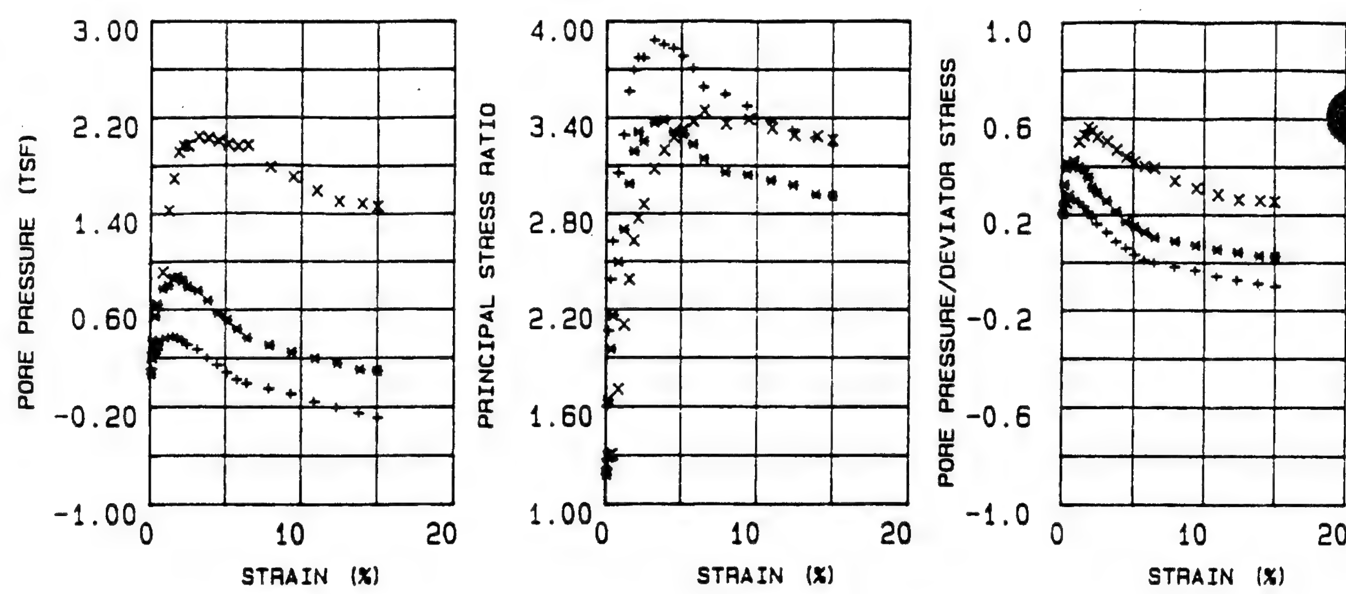
DEPTH ELEV 33'-35'

LABORATORY 90/135 DATE

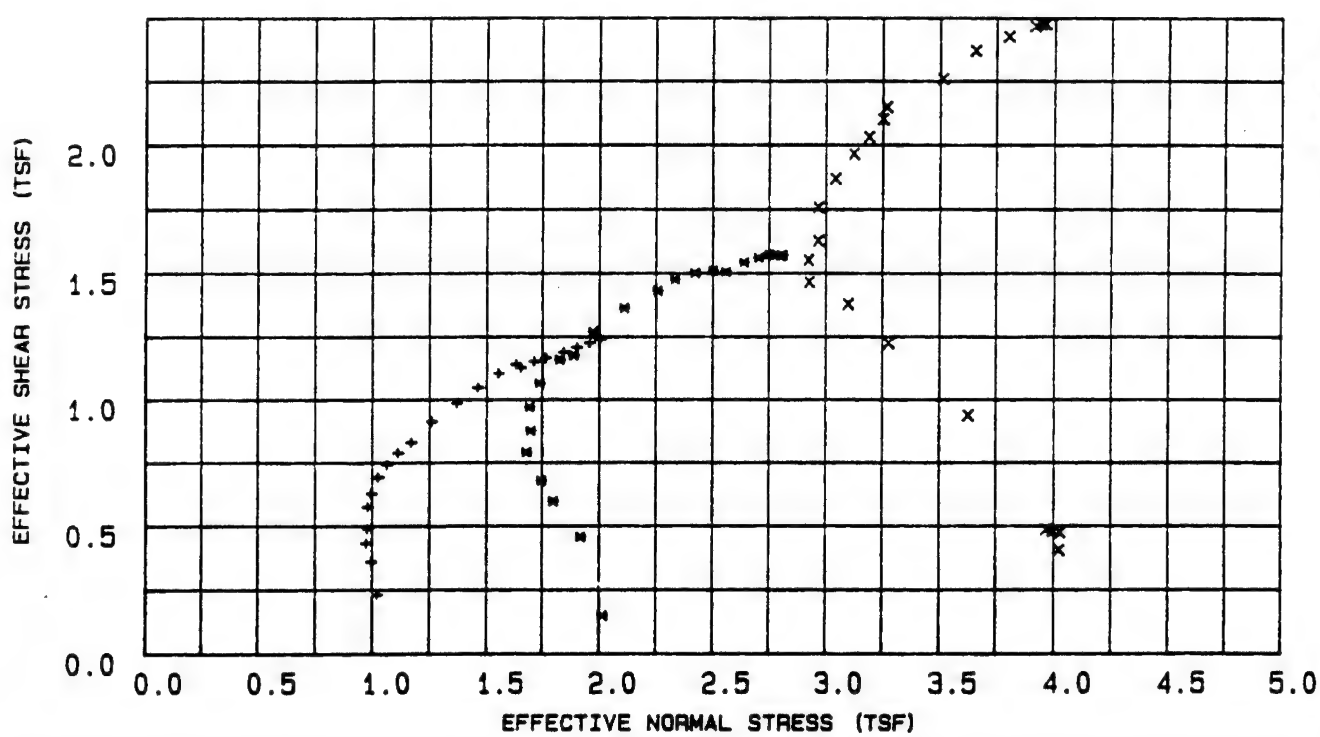
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 14



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = 1 TSF
✱ = 2 TSF
X = 4 TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-119 MU
SAMPLE NO.	S-6
DEPTH/ELEV	33'-35'
MRD LAB NO.	90/135

FIGURE 15

Table 4 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-119 MU
Sample Number : S-6
Depth : 33'-35'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.09	0.535	0.109	1.601	0.204	1.024	0.231
30	0.19	0.837	0.213	2.064	0.255	0.994	0.361
45	0.34	1.004	0.277	2.388	0.276	0.972	0.433
60	0.48	1.135	0.302	2.627	0.267	0.979	0.490
90	0.83	1.332	0.351	3.051	0.264	0.979	0.575
120	1.19	1.456	0.365	3.292	0.251	0.995	0.628
150	1.53	1.607	0.373	3.564	0.233	1.025	0.693
180	1.84	1.721	0.362	3.697	0.211	1.064	0.743
210	2.12	1.828	0.341	3.774	0.187	1.111	0.789
240	2.48	1.922	0.307	3.773	0.160	1.169	0.830
300	3.17	2.119	0.266	3.886	0.126	1.259	0.914
360	3.81	2.288	0.198	3.853	0.087	1.368	0.987
4[illegible]	4.46	2.429	0.141	3.828	0.059	1.460	1.048
480	5.08	2.560	0.080	3.782	0.032	1.554	1.105
540	5.75	2.645	0.022	3.704	0.009	1.633	1.142
600	6.44	2.611	-0.009	3.589	-0.003	1.655	1.127
720	7.87	2.673	-0.051	3.544	-0.018	1.713	1.154
840	9.32	2.706	-0.095	3.472	-0.034	1.765	1.168
960	10.85	2.758	-0.160	3.377	-0.058	1.843	1.190
1080	12.30	2.801	-0.208	3.319	-0.074	1.901	1.209
1200	13.80	2.846	-0.252	3.274	-0.088	1.957	1.228
1298	15.00	2.876	-0.291	3.229	-0.100	2.003	1.241

Table 5 - Triaxial $\bar{R}$ Test Results

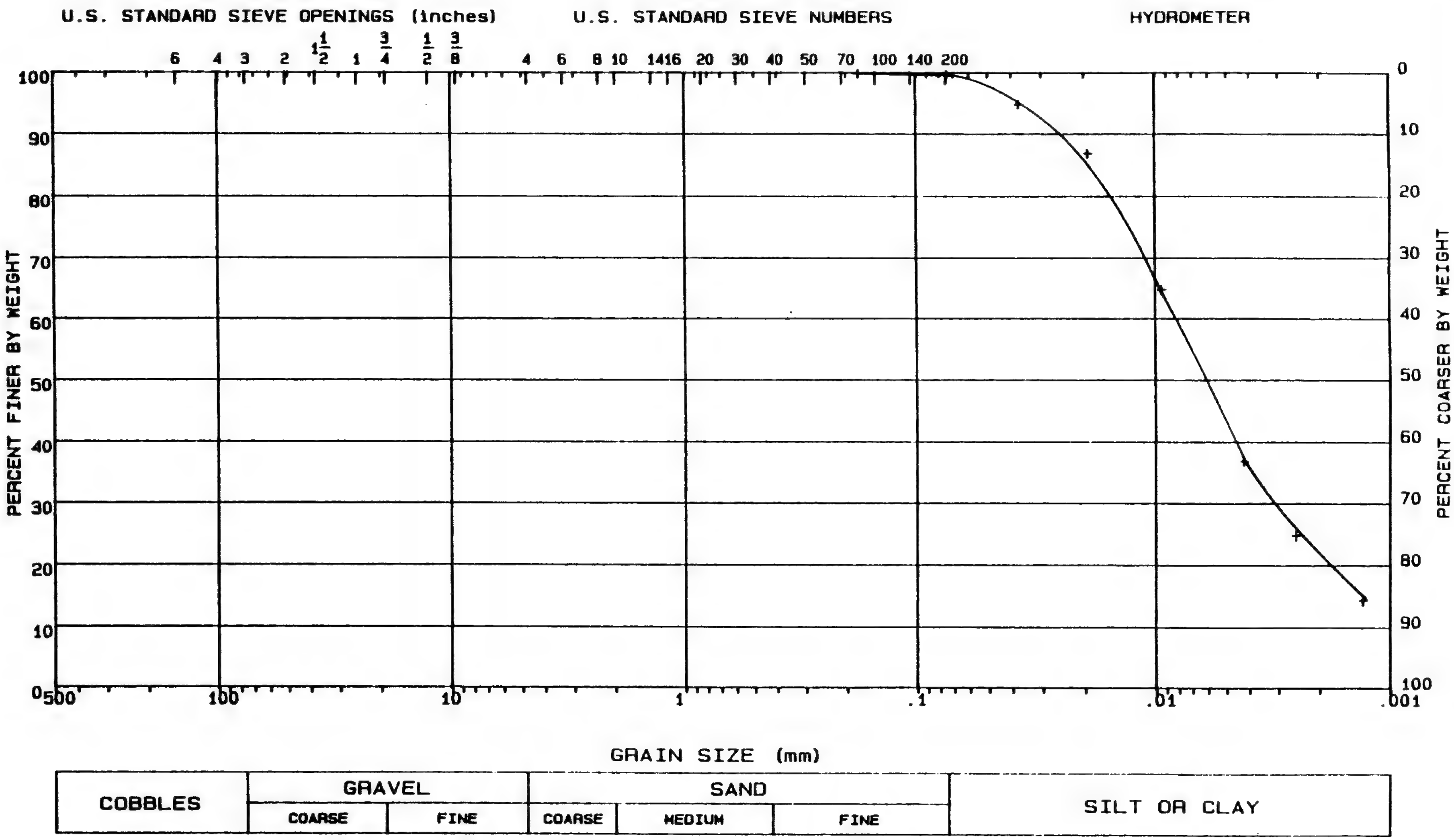
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-119 MU
Sample Number : S-6
Depth : 33'-35'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.09	0.347	0.071	1.180	0.204	2.015	0.150
30	0.19	1.060	0.343	1.640	0.324	1.919	0.458
45	0.34	1.385	0.545	1.952	0.394	1.798	0.598
60	0.48	1.574	0.644	2.160	0.409	1.746	0.679
90	0.84	1.833	0.774	2.496	0.423	1.680	0.791
120	1.20	2.034	0.804	2.700	0.396	1.699	0.878
150	1.54	2.252	0.865	2.985	0.385	1.693	0.972
180	1.85	2.470	0.873	3.191	0.354	1.738	1.066
210	2.14	2.687	0.838	3.312	0.312	1.827	1.160
240	2.50	2.730	0.788	3.253	0.289	1.888	1.178
300	3.19	2.947	0.756	3.369	0.257	1.974	1.272
360	3.84	3.163	0.674	3.386	0.214	2.109	1.365
420	4.49	3.321	0.565	3.314	0.171	2.257	1.433
480	5.11	3.421	0.513	3.300	0.150	2.334	1.477
5[illegible]	5.78	3.482	0.440	3.232	0.127	2.422	1.503
600	6.48	3.504	0.365	3.143	0.105	2.502	1.512
720	7.92	3.489	0.305	3.058	0.088	2.559	1.506
840	9.38	3.577	0.248	3.042	0.070	2.638	1.544
960	10.92	3.622	0.194	3.006	0.054	2.703	1.563
1080	12.38	~~3.650~~	0.154	2.977	0.043	2.750	1.575
1200	13.89	3.639	~~0.103~~	2.918	0.029	2.798	1.570
1290	15.00	3.643	0.093	2.910	0.026	2.809	1.572

Table 6 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-119 MU
Sample Number : S-6
Depth : 33'-35'
Confining Pressure : 4 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.937	0.207	1.247	0.221	4.025	0.405
30	0.19	1.097	0.244	1.292	0.223	4.028	0.474
45	0.34	1.112	0.279	1.299	0.251	3.996	0.480
60	0.48	1.127	0.311	1.306	0.277	3.968	0.486
90	0.85	2.174	0.911	1.704	0.419	3.627	0.938
120	1.21	2.839	1.426	2.103	0.503	3.277	1.225
150	1.55	3.199	1.693	2.387	0.530	3.099	1.381
180	1.86	3.398	1.915	2.629	0.564	2.926	1.466
210	2.15	3.597	1.968	2.770	0.548	2.922	1.552
240	2.51	3.773	1.968	2.857	0.522	2.966	1.628
300	3.21	4.070	2.043	3.080	0.503	2.965	1.757
360	3.87	4.331	2.029	3.197	0.469	3.043	1.869
420	4.52	4.553	2.003	3.280	0.440	3.124	1.965
480	5.15	4.705	1.975	3.324	0.420	3.190	2.031
5	5.82	4.869	1.954	3.379	0.402	3.251	2.101
600	6.52	4.977	1.964	3.444	0.395	3.268	2.148
720	7.97	5.234	1.784	3.362	0.341	3.512	2.259
840	9.45	5.494	1.703	3.392	0.310	3.657	2.371
960	10.99	5.625	1.589	3.333	0.283	3.804	2.428
1080	12.47	5.722	1.502	3.291	0.263	3.915	2.470
1200	13.99	5.746	~~1.483~~	3.283	0.259	3.940	2.480
1282	15.00	~~5.741~~	1.460	3.261	0.255	3.961	2.478



LL = 33	PL = 16	PI = 17	Gs = 2.72	NAT w = %

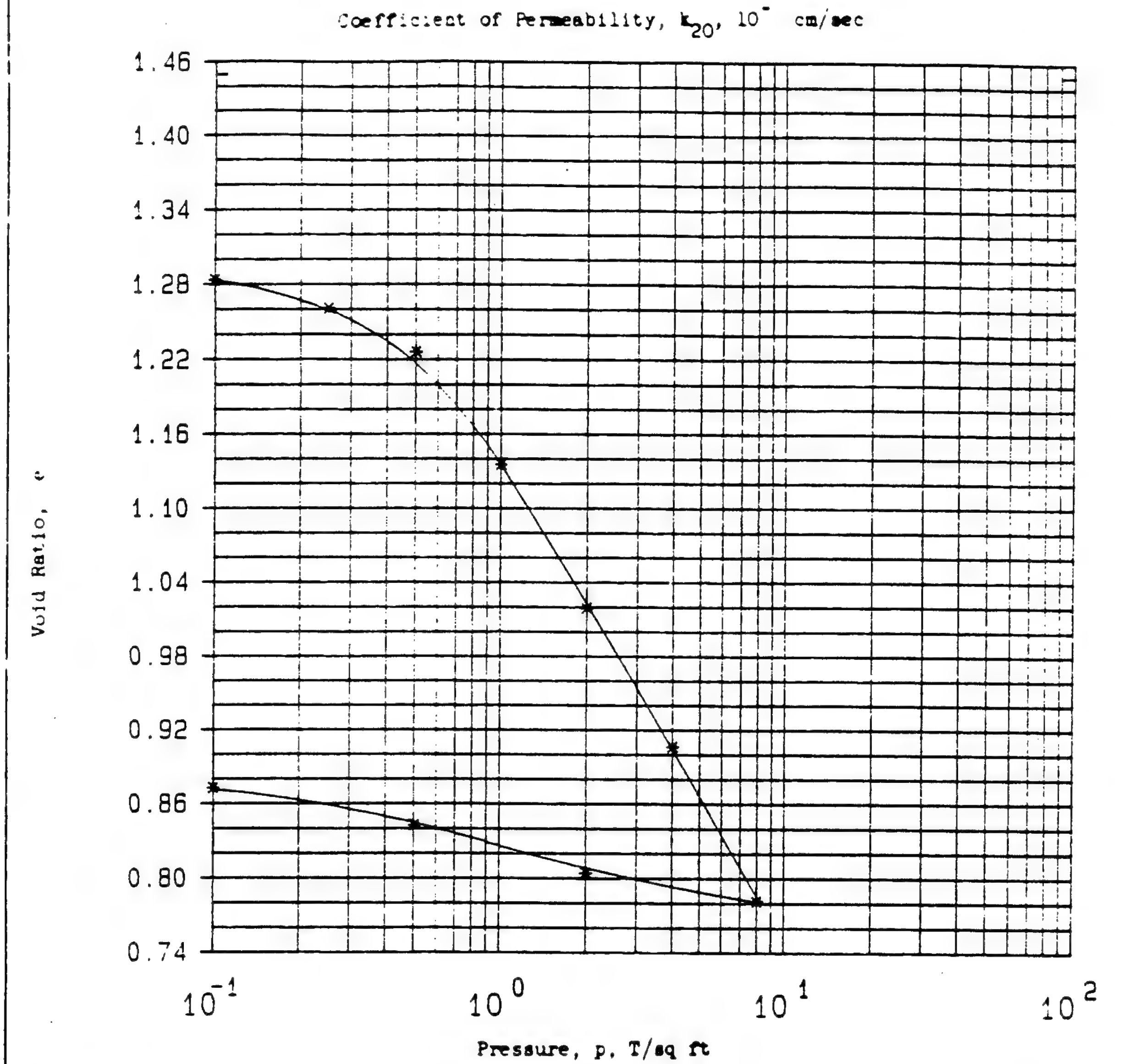
CLASSIFICATION Lean clay, CL

GRADATION CURVE

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

BORING NO. 89-119 MU
SAMPLE NO. S-6
DEPTH/ELEV 33'-35'
MRD LAB NO. 90/135

FIGURE 16



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.3 in.	Ht 1 in.	Water Content, w_o	54.0 %	w_f	34.5 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.45	e_f	0.87
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	99 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	67.8 lb/ft^3		
Classification Fat clay, CH		k_{20} at e_o = × 10^{-} cm/sec			
LL 64	G_s 2.66				
PL 49	D_{10}				

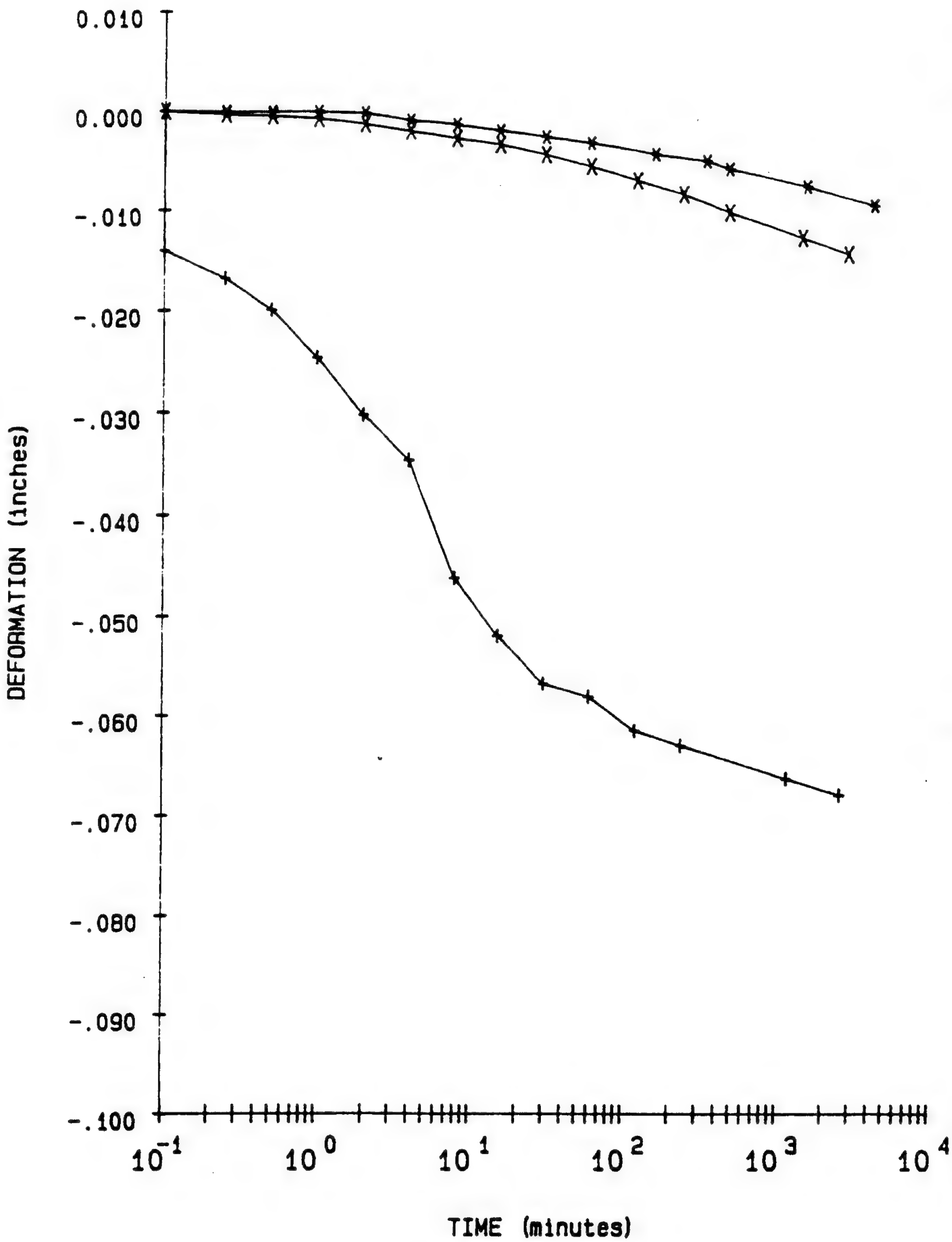
Remarks Dark gray. Torvane=0.25TSF. Slightly calcareous organic.

Project	MINNESOTA RIVER; IA-90-04-ED-GH		
Area	MRD LAB NO. 90/135		
Boring No.	89-126 MU	Sample No.	S-1
Depth El	12'-14'	Date	

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

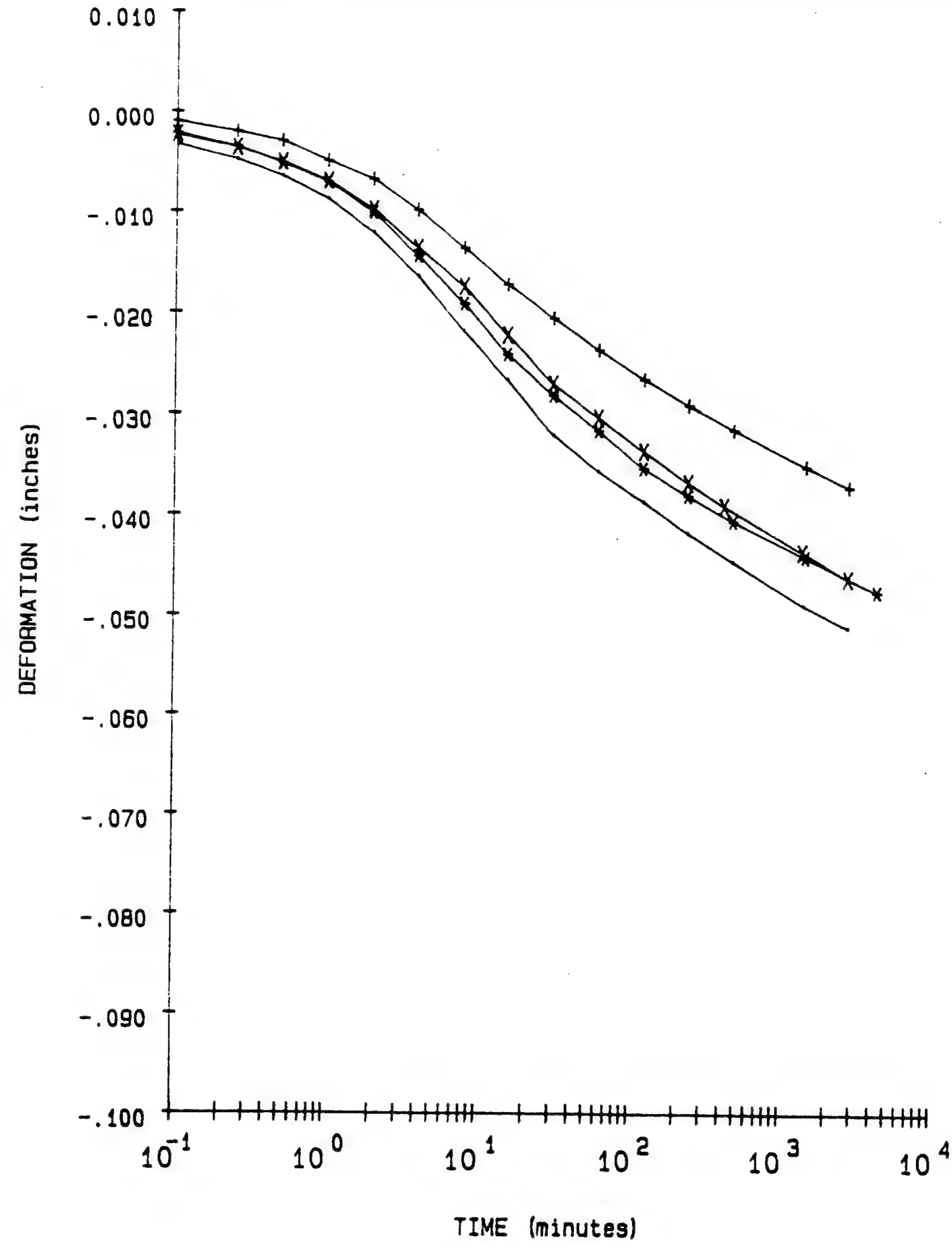
Figure 17



LEGEND	
+ =	.1 TSF
* =	.25 TSF
X =	.5 TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-126 MU
SAMPLE NO.	S-1
DEPTH/ELEV	12'-14'
MRD LAB NO.	90/135

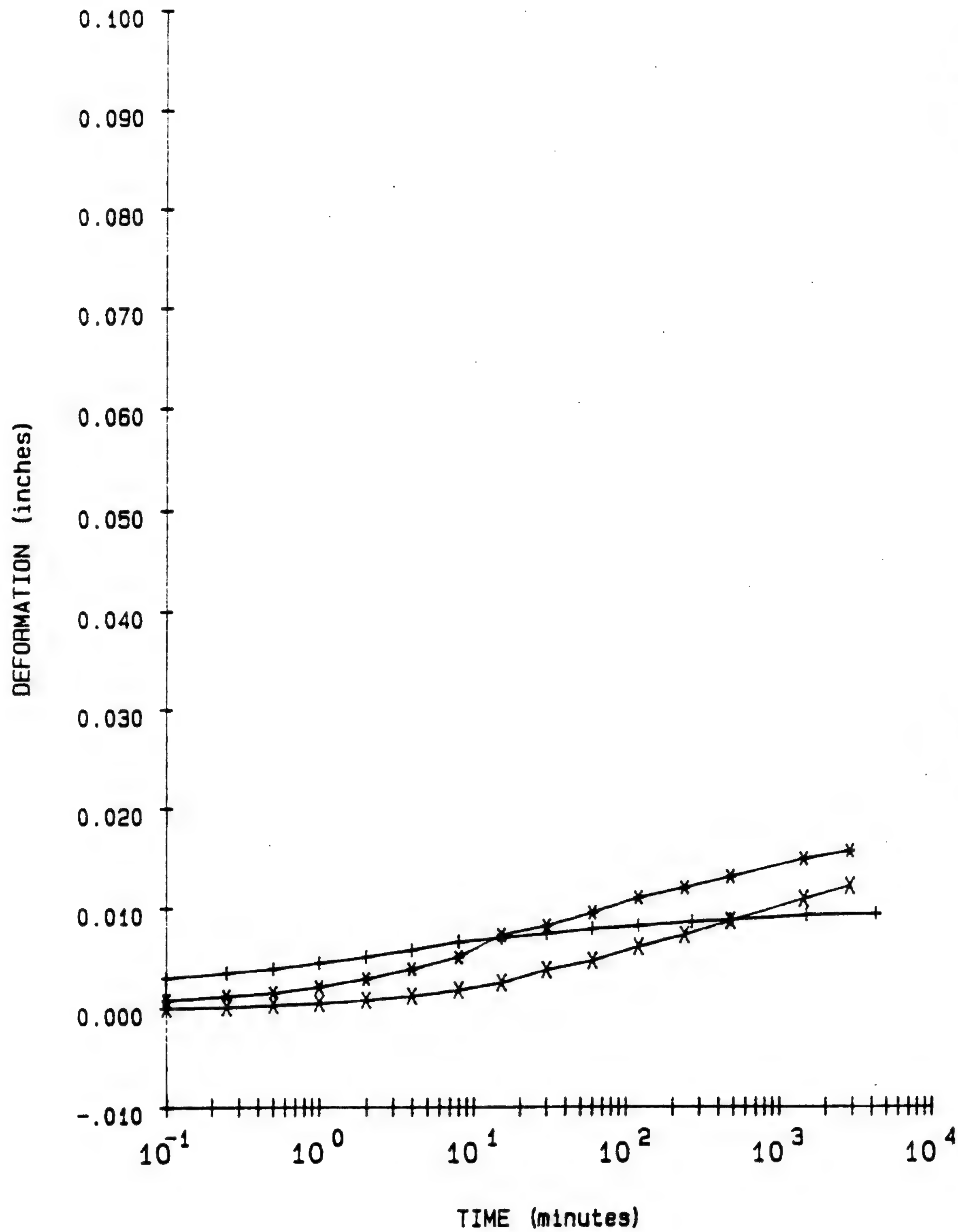
FIGURE 18



LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-126 MU
SAMPLE NO.	S-1
DEPTH/ELEV	12'-14'
MRD LAB NO.	90/135

FIGURE 19



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-126 MU
SAMPLE NO.	S-1
DEPTH/ELEV	12'-14'
MRD LAB NO.	90/135

FIGURE 20

Consolidation Test Data

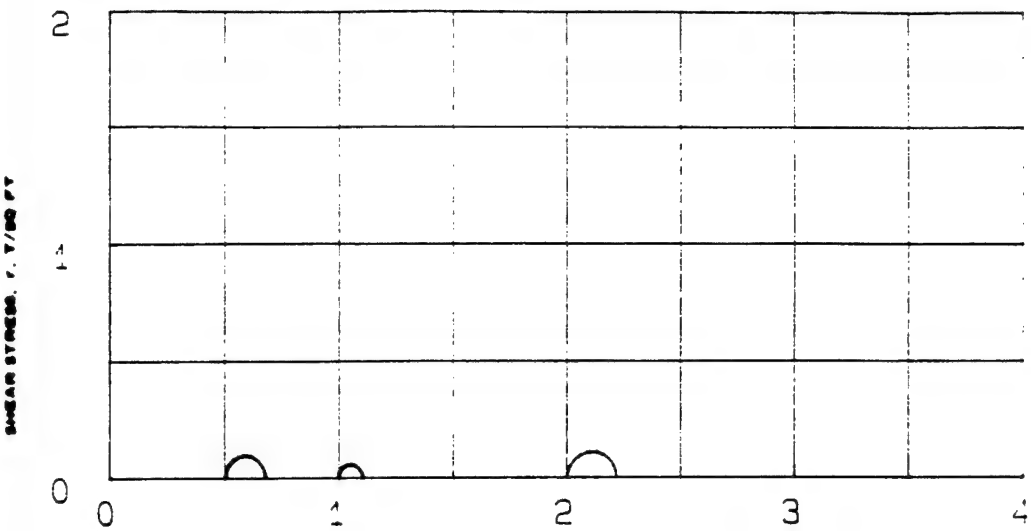
Project MINNESOTA RIVER; IA-90-04-ED-GH

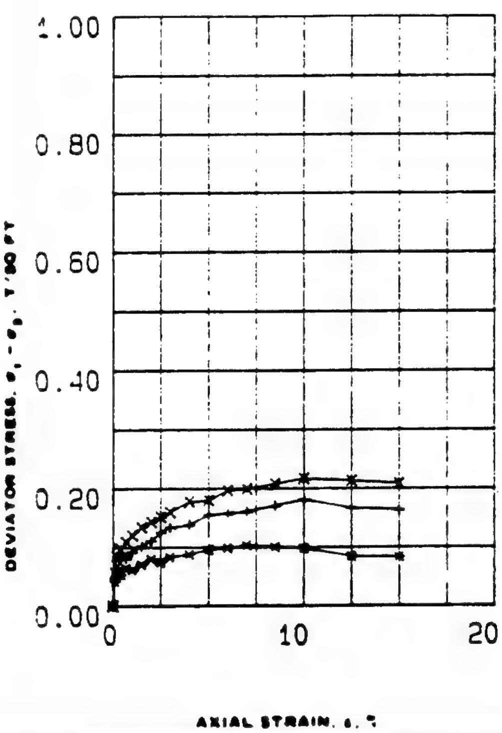
Boring No. 89-126 MU
Sample No. S-1
Depth/Elev 12'-14'
MRD Lab No. 90/135

Gs = 2.66
eo = 1.450
0.42eo = 0.609

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
54.0	257.1	67.8	1.450		99.1
34.5	257.1	72.7	1.283	0.10	71.5
34.5	257.1	73.4	1.260	0.25	72.8
34.5	257.1	74.6	1.226	0.50	74.9
34.5	257.1	77.7	1.135	1.00	80.9
34.5	257.1	82.2	1.019	2.00	90.1
34.5	257.1	87.1	0.906	4.00	100.0
34.5	257.1	93.2	0.781	8.00	100.0
34.5	257.1	92.0	0.804	2.00	100.0
34.5	257.1	90.1	0.843	0.50	100.0
34.5	257.1	88.6	0.872	0.10	100.0

Axial Strain (%)	Void Ratio
1	1.425
2	1.401
3	1.376
4	1.352
5	1.327
6	1.303
7	1.278
8	1.254
9	1.229
10	1.205
11	1.180
12	1.156
13	1.131
14	1.107
15	1.082
16	1.058
17	1.033
18	1.009
19	0.984
20	0.960





NORMAL STRESS, σ, T/SQ FT

SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	39.1	41.5	36.7	
	DRY DENSITY LB/CU FT	γ_{d_o}	83.5	79.6	89.9	
	SATURATION, %	S_o	100.0	100.0	100.0	
	VOID RATIO	e_o	0.99	1.09	0.85	
BEFORE SHEAR	WATER CONTENT, %	w_c	39.0	42.0	36.4	
	DRY DENSITY LB/CU FT	γ_{d_c}	83.5	79.6	89.9	
	SATURATION, %	S_c	100.0	100.0	100.0	
	VOID RATIO	e_c	0.99	1.09	0.85	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.18	0.10	0.22	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	20.5	14.3	19.8	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.16	0.08	0.21	
INITIAL DIAMETER, IN.		D_o	1.37	1.39	1.38	
INITIAL HEIGHT, IN.		H_o	2.98	2.98	2.88	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH

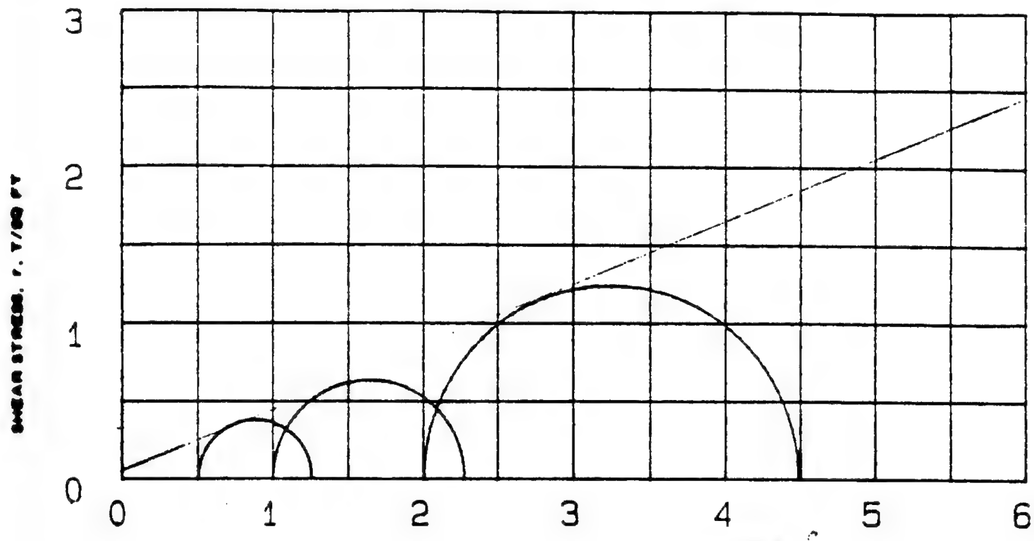
LL 64	PL 49	PI 15	G_s 2.66	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Dark gray. Torvane=0.25 TSF. Slightly calcareous organic.

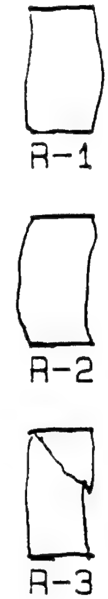
PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO 89-126 MU	SAMPLE NO. S-1
DEPTH ELEV	12'-14'
LABORATORY 90/135	DATE

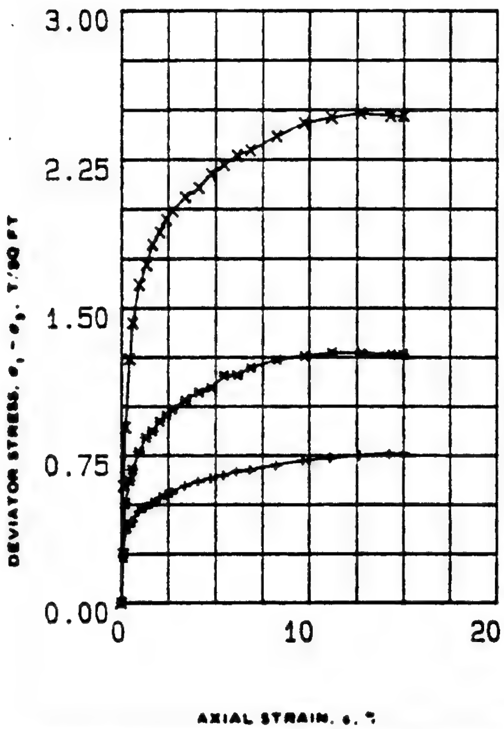
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2088 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 21



c ~ 100 psf
φ ~ 21





SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	42	44.3	41	
	DRY DENSITY LB/CU FT	γ_{d_o}	78.8	75.6	79.5	
	SATURATION, %	S_o	100	98	100	
	VOID RATIO	e_o	1.11	1.2	1.09	
BEFORE SHEAR	WATER CONTENT, %	w_c	41.3	39.8	37.1	
	DRY DENSITY LB/CU FT	γ_{d_c}	79.6	80.7	85.7	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	1.09	1.06	.94	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.759	1.274	2.483	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1200	960	1080	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.756	1.262	2.469	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.38	
INITIAL HEIGHT, IN.		H_o	2.95	2.97	3	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH B-Value 1.0 1.0 1.0

LL 64	PL 49	PI 15	G_s 2.66	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Dark gray. Torvane=0.25 TSF. Slightly calcareous organic.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

BORING NO 89-126MU SAMPLE NO. S-1

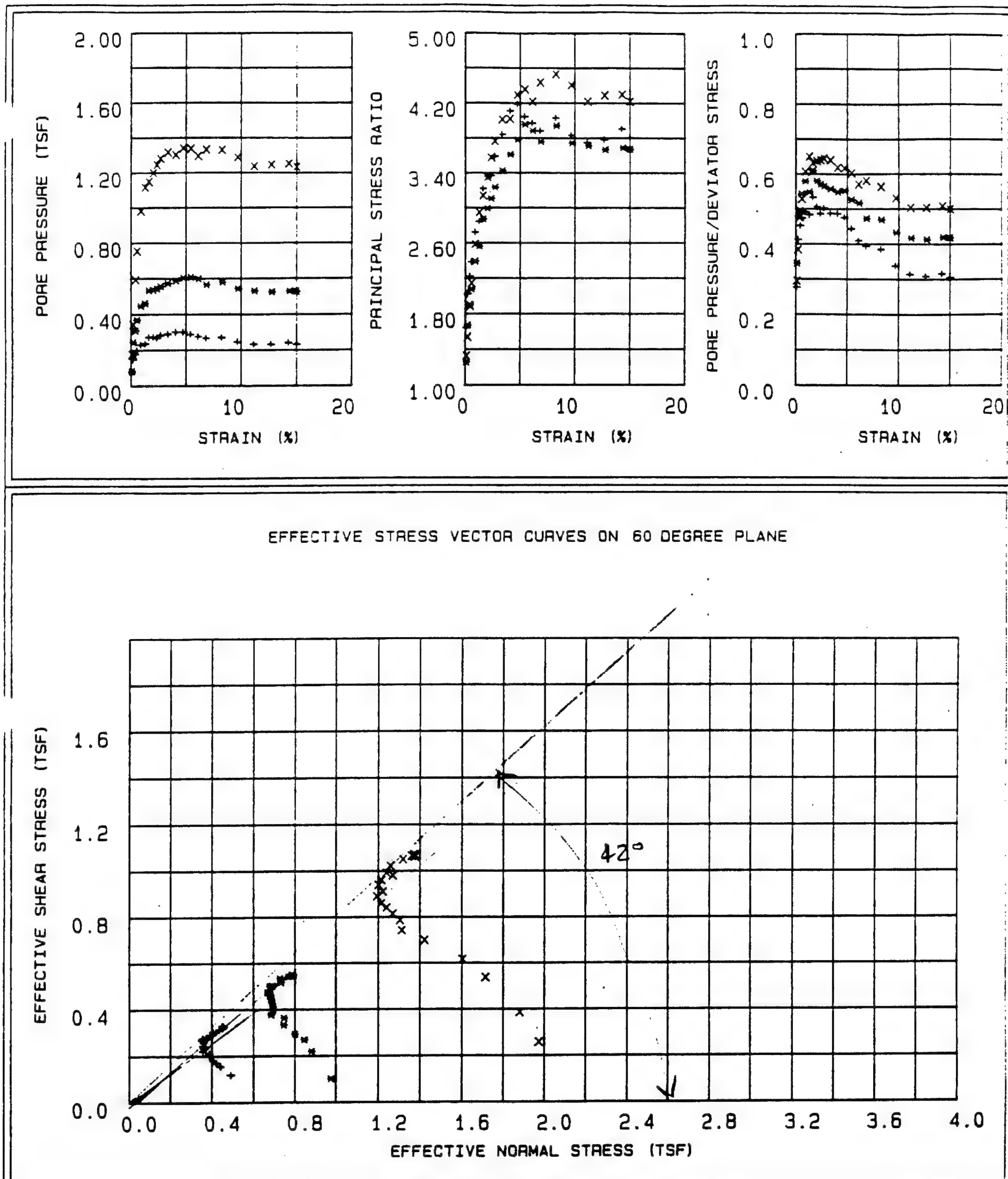
DEPTH ELEV 12.0'-14.0'

LABORATORY 90/135 DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 22



LEGEND

+ = .5 TSF

✱ = 1 TSF

X = 2 TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-126MU
SAMPLE NO.	S-1
DEPTH/ELEV	12.0'-14.0'
MRD LAB NO.	90/135

FIGURE 23

R

Table 7 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-126MU
Sample Number : S-1
Depth : 12.0'-14.0'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.273	0.075	1.642	0.276	0.492	0.118
30	0.22	0.360	0.148	2.024	0.412	0.441	0.155
45	0.44	0.393	0.177	2.218	0.452	0.420	0.170
60	0.58	0.418	0.198	2.382	0.474	0.405	0.180
90	0.92	0.466	0.229	2.719	0.491	0.386	0.201
120	1.29	0.487	0.235	2.841	0.483	0.386	0.210
150	1.63	0.509	0.271	3.220	0.533	0.355	0.220
180	2.02	0.538	0.272	3.359	0.506	0.361	0.232
210	2.36	0.551	0.268	3.368	0.486	0.368	0.238
240	2.70	0.563	0.283	3.589	0.502	0.356	0.243
300	3.36	0.596	0.290	3.840	0.487	0.358	0.257
360	4.06	0.619	0.301	4.109	0.486	0.352	0.267
420	4.72	0.634	0.301	4.185	0.475	0.356	0.274
[illegible]	5.40	0.649	0.287	4.043	0.443	0.374	0.280
[illegible]	6.09	0.671	0.274	3.969	0.409	0.392	0.290
600	6.81	0.676	0.265	3.879	0.393	0.402	0.292
720	8.22	0.701	0.269	4.029	0.384	0.405	0.303
840	9.66	0.725	0.244	3.829	0.337	0.435	0.313
960	11.10	0.739	0.231	3.746	0.313	0.452	0.319
1080	12.63	0.750	0.230	3.777	0.307	0.456	0.324
1200	14.21	0.759	0.239	3.904	0.315	0.449	0.328
1261	15.00	0.756	0.230	3.800	0.304	0.457	0.326

Table 8 - Triaxial $\bar{R}$ Test Results

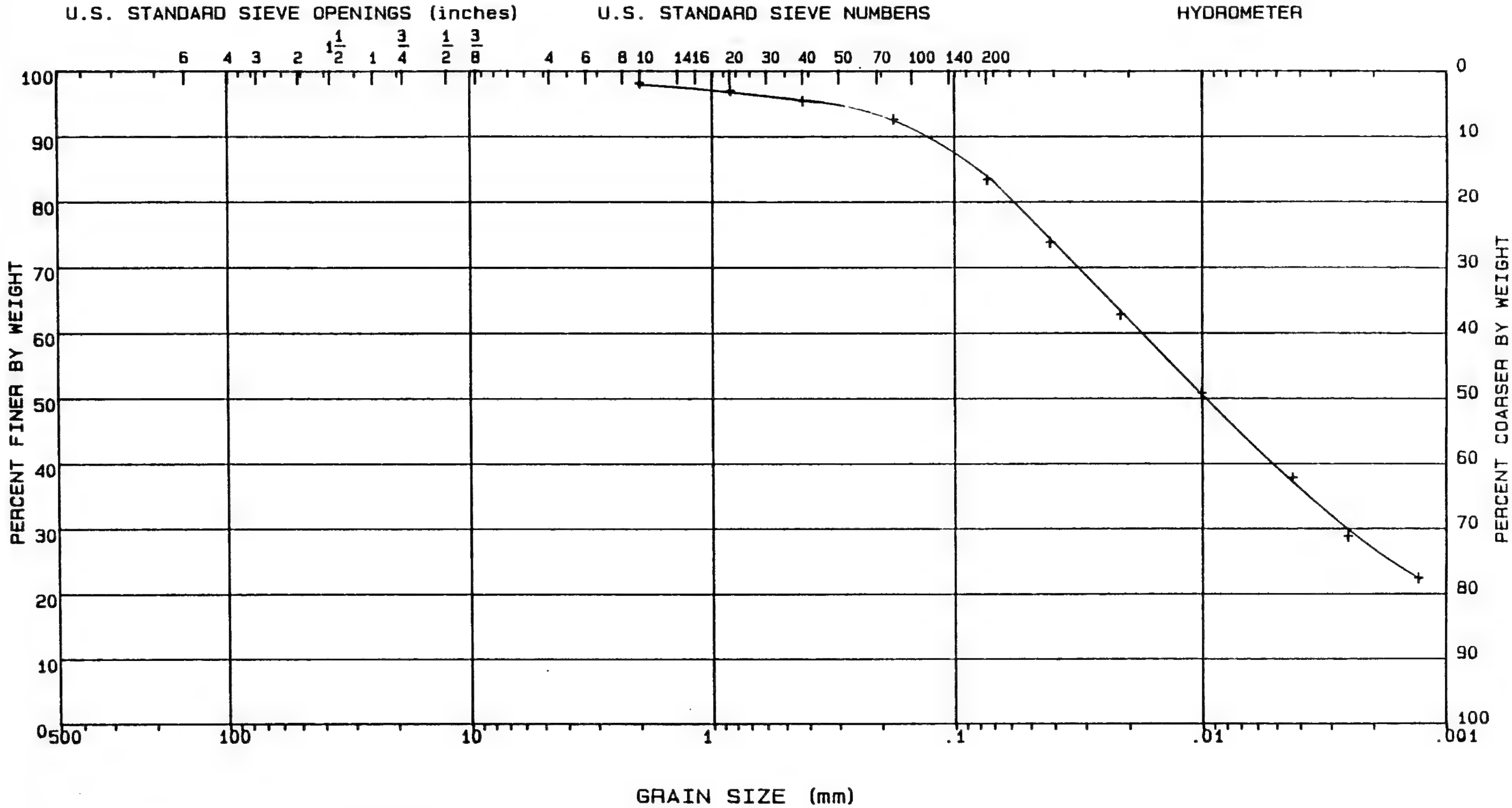
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-126MU
Sample Number : S-1
Depth : 12.0'-14.0'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.234	0.081	1.255	0.344	0.977	0.101
30	0.22	0.508	0.243	1.671	0.479	0.883	0.219
45	0.44	0.623	0.308	1.900	0.495	0.846	0.269
60	0.59	0.679	0.368	2.075	0.543	0.800	0.293
90	0.93	0.771	0.446	2.391	0.579	0.745	0.333
120	1.30	0.842	0.461	2.563	0.548	0.747	0.363
150	1.65	0.874	0.533	2.871	0.610	0.684	0.377
180	2.04	0.925	0.536	2.992	0.580	0.693	0.399
210	2.39	0.957	0.545	3.103	0.570	0.692	0.413
240	2.73	0.988	0.557	3.233	0.564	0.688	0.427
300	3.39	1.032	0.574	3.425	0.557	0.682	0.445
360	4.11	1.074	0.588	3.609	0.548	0.678	0.464
420	4.77	1.097	0.605	3.781	0.552	0.667	0.474
480	5.46	1.157	0.608	3.955	0.526	0.678	0.499
5[illegible]	6.15	1.160	0.598	3.883	0.516	0.689	0.501
600	6.88	1.199	0.565	3.756	0.472	0.732	0.517
720	8.31	1.238	0.579	3.941	0.468	0.728	0.534
840	9.76	1.257	0.542	3.743	0.432	0.769	0.542
960	11.21	1.274	0.529	3.708	0.416	0.787	0.550
1080	12.76	1.270	0.523	3.665	0.412	0.792	0.548
1200	14.36	1.264	0.529	3.687	0.419	0.784	0.546
1249	15.00	1.262	0.527	3.667	0.418	0.786	0.545

Table 9 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-126MU
Sample Number : S-1
Depth : 12.0'-14.0'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.595	0.174	1.326	0.294	1.973	0.257
30	0.22	0.892	0.341	1.538	0.383	1.880	0.385
45	0.44	1.241	0.592	1.882	0.477	1.715	0.536
60	0.59	1.424	0.752	2.141	0.528	1.601	0.615
90	0.93	1.619	0.980	2.587	0.606	1.421	0.699
120	1.30	1.720	1.115	2.944	0.649	1.311	0.742
150	1.64	1.821	1.148	3.137	0.631	1.303	0.786
180	2.03	1.883	1.198	3.349	0.637	1.268	0.813
210	2.37	1.946	1.244	3.574	0.640	1.238	0.840
240	2.71	1.990	1.280	3.763	0.644	1.213	0.859
300	3.37	2.060	1.316	4.011	0.639	1.194	0.889
360	4.08	2.109	1.301	4.018	0.618	1.221	0.910
420	4.74	2.176	1.339	4.291	0.616	1.200	0.939
480	5.43	2.224	1.337	4.355	0.602	1.214	0.960
540	6.11	2.271	1.293	4.212	0.570	1.269	0.980
600	6.84	2.297	1.331	4.432	0.580	1.238	0.992
720	8.26	2.367	1.329	4.528	0.562	1.257	1.022
840	9.71	2.433	1.285	4.402	0.529	1.317	1.050
960	11.15	2.461	1.234	4.214	0.502	1.375	1.062
1080	12.69	2.483	1.244	4.285	0.502	1.371	1.072
1200	14.27	2.468	1.251	4.294	0.507	1.360	1.065
1256	15.00	2.469	1.231	4.215	0.499	1.379	1.066



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

LL - 64	PL - 49	PI - 15	Gs - 2.66	NAT w - %

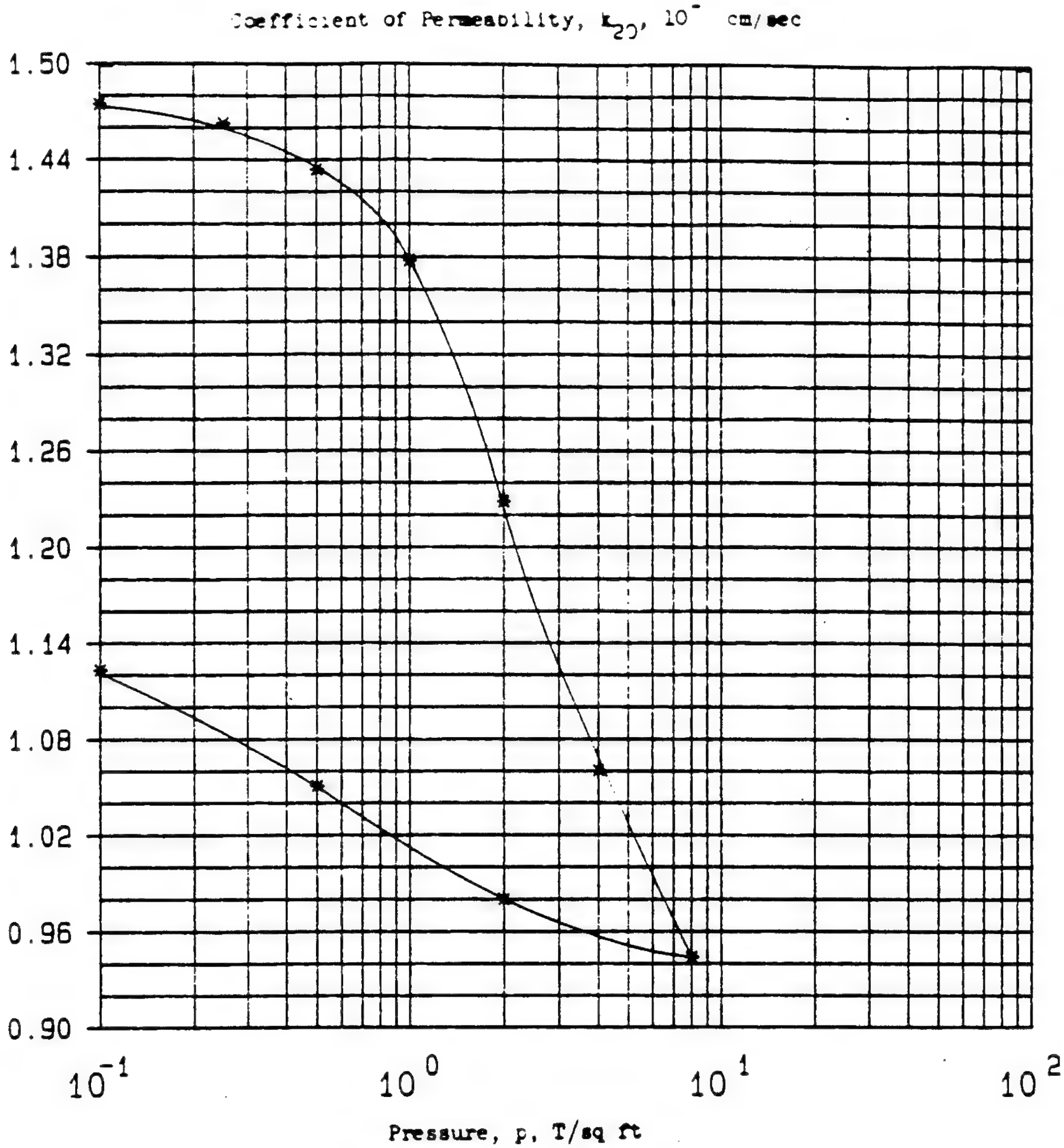
CLASSIFICATION Fat clay, CH.

GRADATION CURVE

PROJECT	MINNESOTA RIVER; IA-90-04 ·ED-GH
BORING NO.	89-126 MU
SAMPLE NO.	S-1
DEPTH/ELEV	12'-14'
MRD LAB NO.	90/135

FIGURE 24

Figure C-476



Type of Specimen UNDISTURBED		Before Test		After Test		
Diam 4.4 in.	Ht 1 in.	Water Content, w_o	54.0 %	w_f	54.0 %	
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.50	e_f	1.12	
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	97 %	S_f	100 %	
Compression Index, C_c		Dry Density, γ_d	67.2 lb/ft^3			
Classification Fat clay, CH		k_{20} at e_o =	× 10^{-} cm/sec			

LL 67	G_s 2.69
PL 23	D_{10}

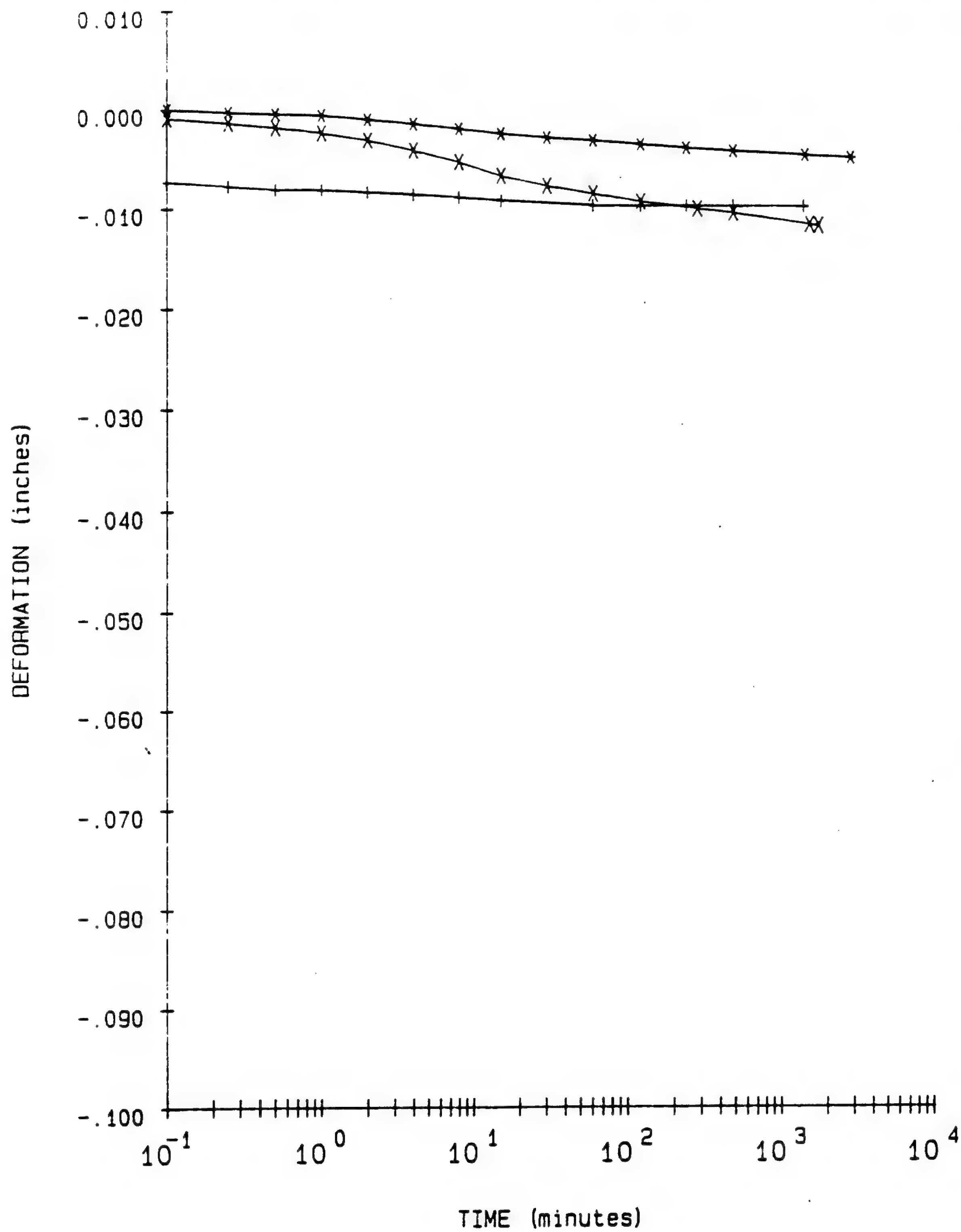
Remarks Dark gray. Torvane=0.55TSF. Slightly organic. Non-calcareous.

Project	MINNESOTA RIVER; IA-90-04-ED-GH		
Area	MRD LAB NO. 90/135		
Boring No.	89-126 MU	Sample No.	S-2
Depth El	22'-24'	Date	

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

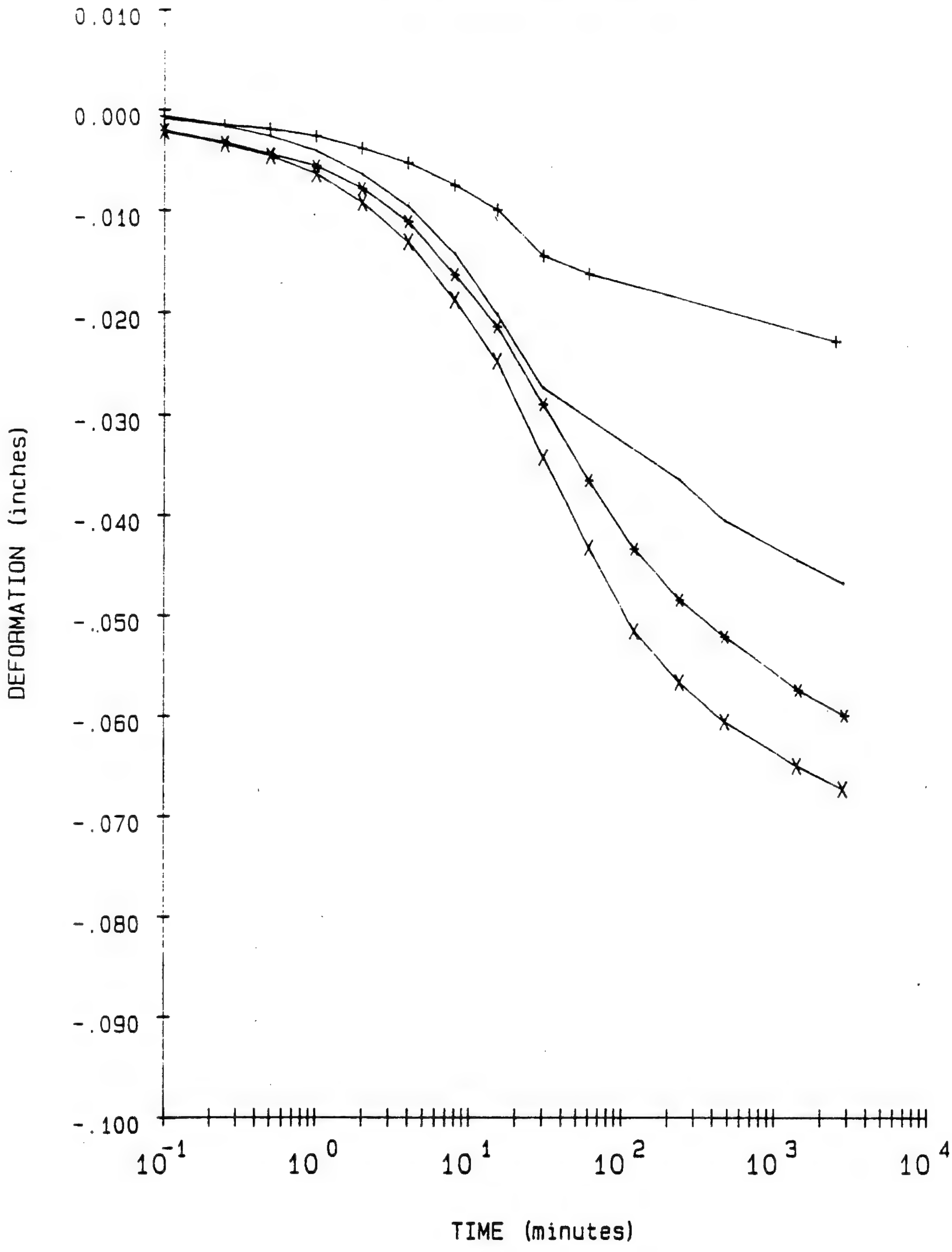
Figure 5



LEGEND
+ = .1 TSF
* = .25 TSF
X = .5 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-126 MU
SAMPLE NO.	S-2
DEPTH/ELEV	22'-24'
MRD LAB NO.	90/135

FIGURE 6

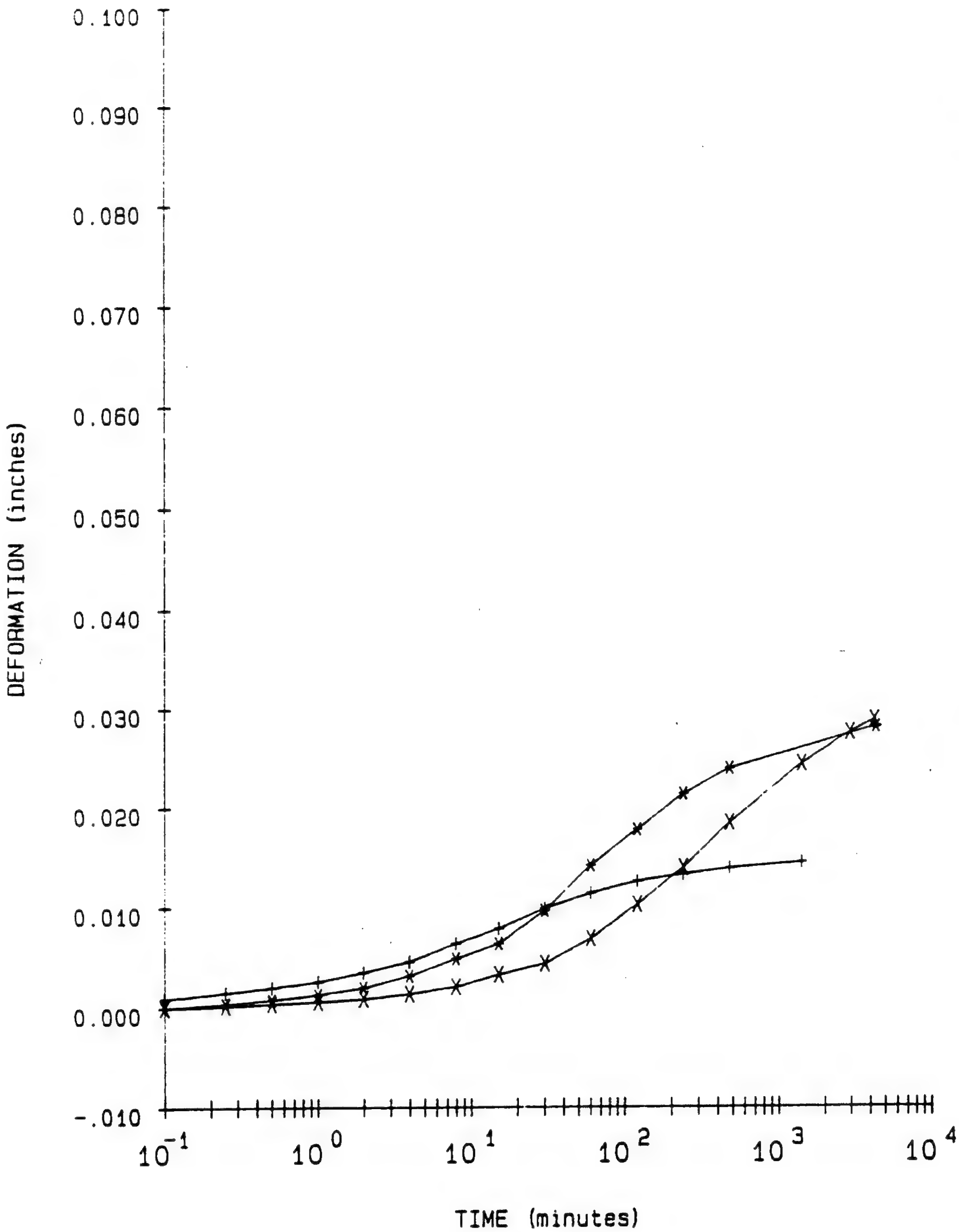


LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF
- = 8 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-126 MU
SAMPLE NO.	S-2
DEPTH/ELEV	22'-24'
MRD LAB NO.	90/135

FIGURE 7



LEGEND

+ = 2 TSF Rebound

✱ = .5 TSF Rebound

X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-126 MU
SAMPLE NO.	S-2
DEPTH/ELEV	22'-24'
MRD LAB NO.	90/135

FIGURE 8

Consolidation Test Data

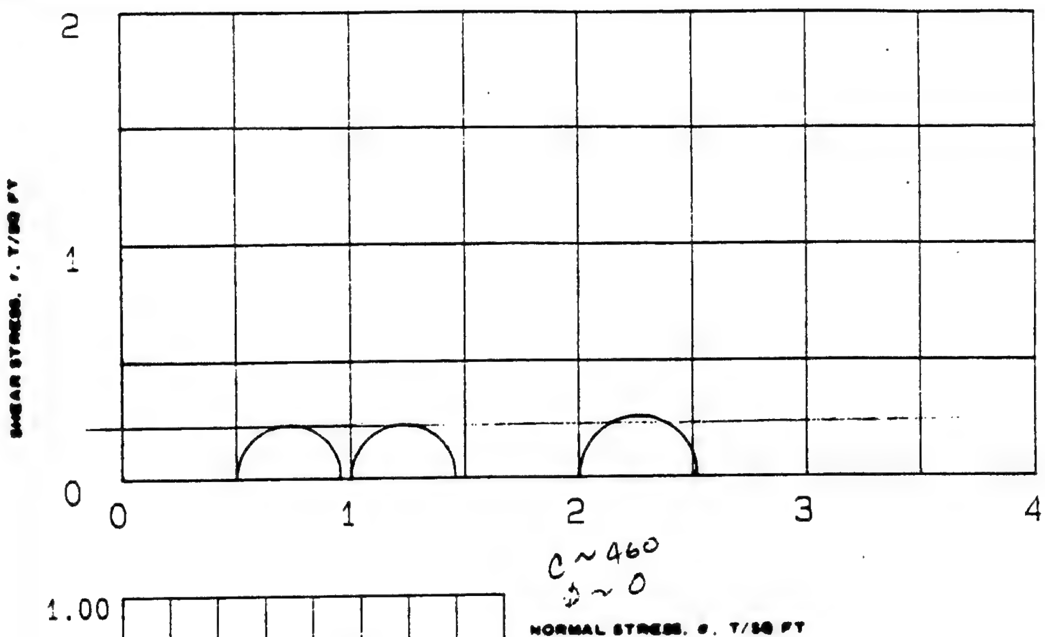
Project MINNESOTA RIVER; IA-90-04-ED-GH

Boring No. 89-126 MU
Sample No. S-2
Depth/Elev 22'-24'
MRD Lab No. 90/135

Gs = 2.69
eo = 1.499
0.42eo = 0.629

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
54.0	272.9	67.2	1.499		96.9
54.0	272.9	67.8	1.474	0.10	98.5
54.0	272.9	68.2	1.463	0.25	99.3
54.0	272.9	69.0	1.434	0.50	100.0
54.0	272.9	70.6	1.377	1.00	100.0
54.0	272.9	75.3	1.228	2.00	100.0
54.0	272.9	81.5	1.060	4.00	100.0
54.0	272.9	86.4	0.944	8.00	100.0
54.0	272.9	84.8	0.980	2.00	100.0
54.0	272.9	81.9	1.051	0.50	100.0
54.0	272.9	79.1	1.123	0.10	100.0

Axial Strain (%)	Void Ratio
1	1.474
2	1.449
3	1.424
4	1.399
5	1.374
6	1.349
7	1.324
8	1.299
9	1.274
10	1.249
11	1.224
12	1.199
13	1.174
14	1.149
15	1.124
16	1.099
17	1.074
18	1.049
19	1.024
20	0.999



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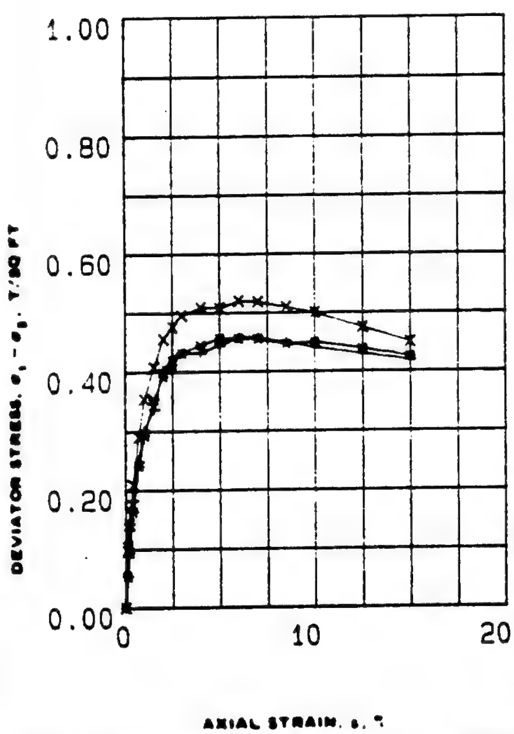
φ ~ 0



SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	49.4	49.7	50.0
	DRY DENSITY LB/CU FT	γd_o	73.5	71.3	72.3
	SATURATION, %	S_o	100.0	98.0	100.0
	VOID RATIO	e_o	1.28	1.36	1.32
BEFORE SHEAR	WATER CONTENT, %	w_c	49.3	49.4	49.9
	DRY DENSITY LB/CU FT	γd_c	73.5	71.3	72.3
	SATURATION, %	S_c	100.0	98.0	100.0
	VOID RATIO	e_c	1.28	1.36	1.32
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.46	0.46	0.52
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	13.0	10.5	12.5
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.42	0.43	0.45
INITIAL DIAMETER, IN.		D_o	1.40	1.42	1.40
INITIAL HEIGHT, IN.		H_o	2.97	2.98	2.98

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH

LL 67	PL 23	PI 44	G_s 2.69	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Dark gray. Torvane=0.55 TSF. Slightly organic. Non-calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

BORING NO 89-126 MU | SAMPLE NO. S-2

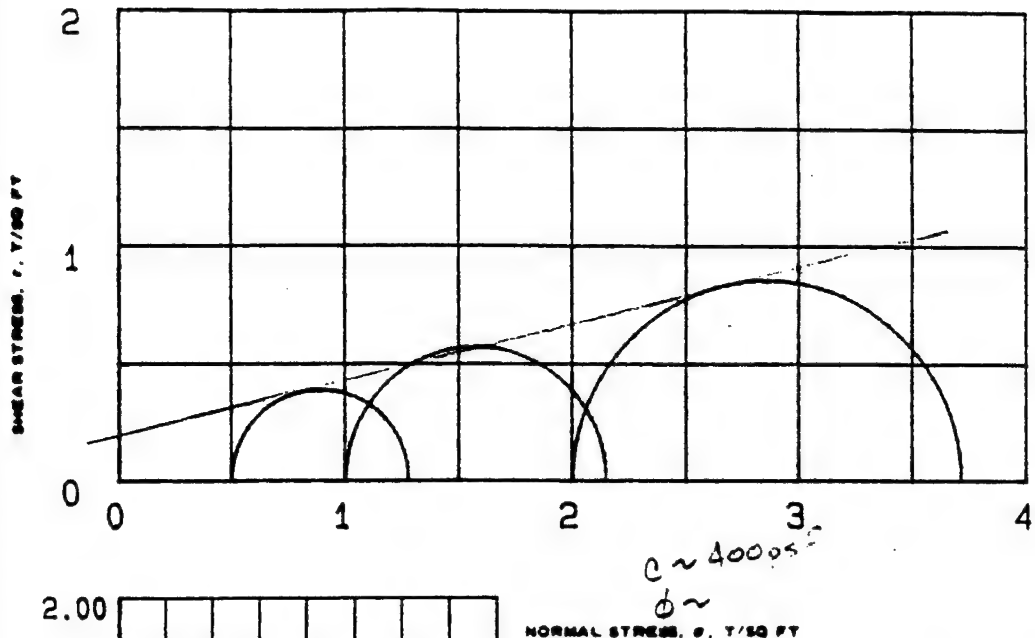
DEPTH ELEV 22'-24'

LABORATORY 90/135 | DATE

TRIAXIAL COMPRESSION TEST REPORT

FIGURE 9

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970



c ~ 400psf
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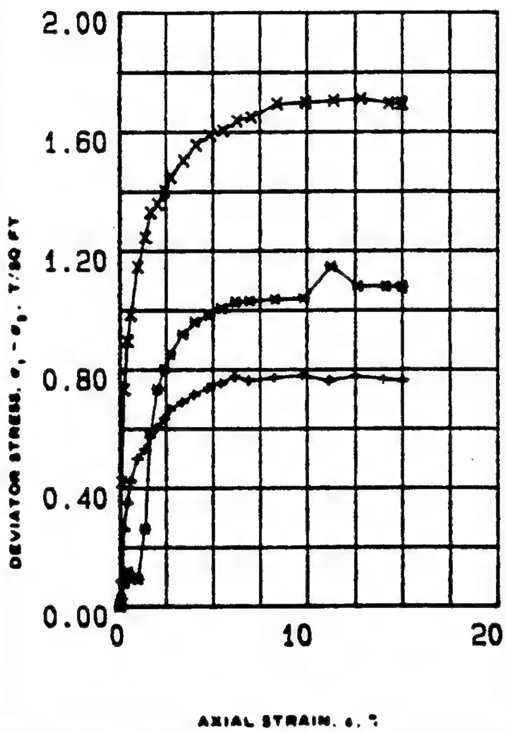


SPECIMEN NO.			1 (+)	2 (✱)	3 (X)
INITIAL	WATER CONTENT, %	w_o	50.7	51	50.5
INITIAL	DRY DENSITY LB/CU FT	γ_{d_o}	70.7	69.9	70.6
INITIAL	SATURATION, %	S_o	99	98	98
INITIAL	VOID RATIO	e_o	1.37	1.4	1.38
BEFORE SHEAR	WATER CONTENT, %	w_c	48.5	45.6	41.8
BEFORE SHEAR	DRY DENSITY LB/CU FT	γ_{d_c}	74.3	75.6	79
BEFORE SHEAR	SATURATION, %	S_c	100	100	100
BEFORE SHEAR	VOID RATIO	e_c	1.28	1.22	1.12
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.780	1.147	1.712
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	840	960	1080
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.762	1.077	1.695
INITIAL DIAMETER, IN.		D_o	1.39	1.41	1.4
INITIAL HEIGHT, IN.		H_o	2.99	2.99	2.99

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH B-Value 1.0 1.0 1.0

LL	PL	PI	G_s
67	23	44	2.69

TYPE OF SPECIMEN UNDISTURBED TYPE OF TEST RBAR

REMARKS: Dark gray. Torvane=0.55 TSF. Slightly organic. Non-calcareous.

PROJECT MINNESOTA RIVER: IA-90-04-ED-GH

BORING NO 89-126 MU SAMPLE NO. S-2

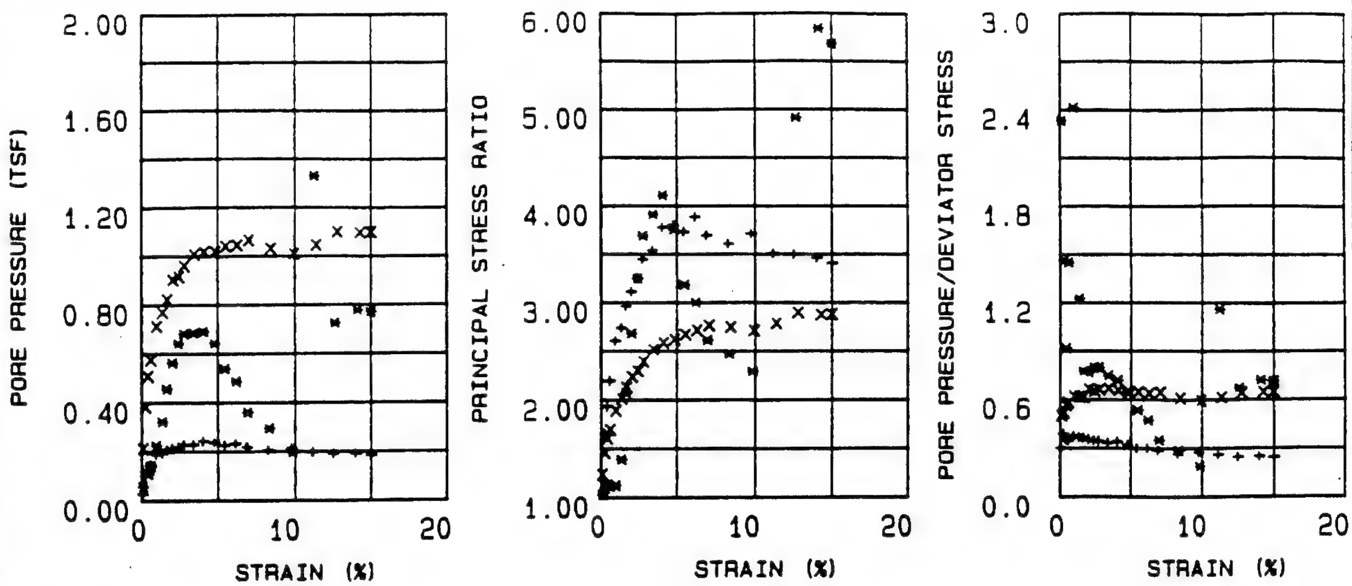
DEPTH ELEV 22'-24'

LABORATORY 90/135 DATE

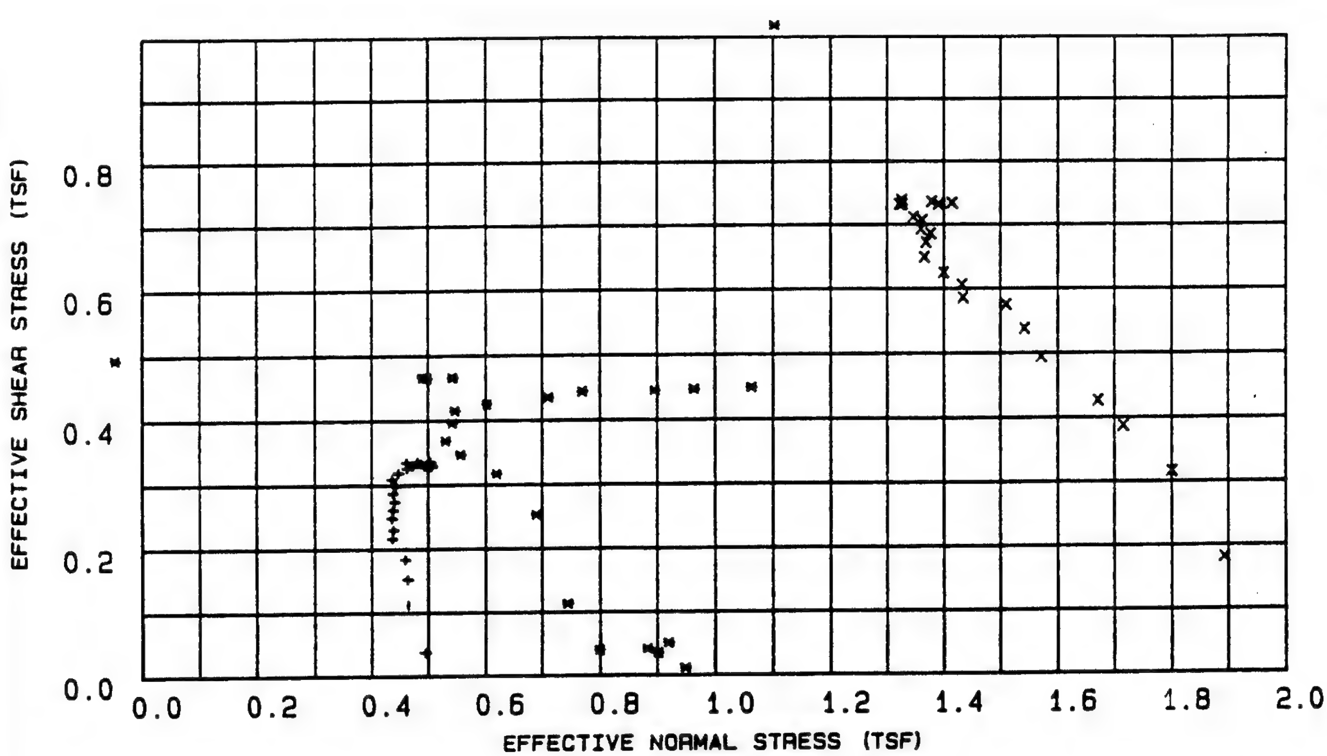
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 10



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF
✱ = 1 TSF
X = 2 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GII
BORING NO.	89-126 MU
SAMPLE NO.	S-2
DEPTH/ELEV	22'-24'
MRD LAB NO.	90/135

FIGURE 11

R

Table 4 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-126 MU
Sample Number : S-2
Depth : 22'-24'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.086	0.026	1.181	0.301	0.495	0.037
30	0.26	0.261	0.101	1.653	0.388	0.464	0.112
45	0.43	0.351	0.124	1.933	0.353	0.463	0.152
60	0.60	0.423	0.146	2.196	0.346	0.459	0.183
90	0.96	0.501	0.188	2.604	0.375	0.436	0.216
120	1.35	0.532	0.194	2.738	0.365	0.438	0.230
150	1.64	0.574	0.207	2.960	0.362	0.435	0.248
180	2.00	0.605	0.213	3.110	0.353	0.437	0.261
210	2.39	0.635	0.217	3.248	0.343	0.440	0.274
240	2.73	0.666	0.228	3.447	0.342	0.437	0.287
300	3.37	0.691	0.228	3.540	0.330	0.443	0.298
360	4.03	0.716	0.242	3.778	0.339	0.435	0.309
420	4.75	0.739	0.236	3.801	0.320	0.447	0.319
4[illegible]	5.42	0.754	0.224	3.729	0.297	0.463	0.326
540	6.15	0.776	0.231	3.885	0.298	0.461	0.335
600	6.89	0.763	0.216	3.691	0.284	0.473	0.329
720	8.27	0.773	0.203	3.602	0.263	0.488	0.333
840	9.74	0.780	0.212	3.710	0.273	0.481	0.336
960	11.14	0.762	0.196	3.505	0.258	0.493	0.329
1080	12.51	0.777	0.189	3.496	0.243	0.503	0.336
1200	13.98	0.766	0.189	3.459	0.247	0.501	0.330
1280	15.00	0.762	0.183	3.406	0.241	0.506	0.329
1280	15.00	0.762	0.183	3.406	0.241	0.506	0.329

Table 5 - Triaxial $\bar{R}$ Test Results

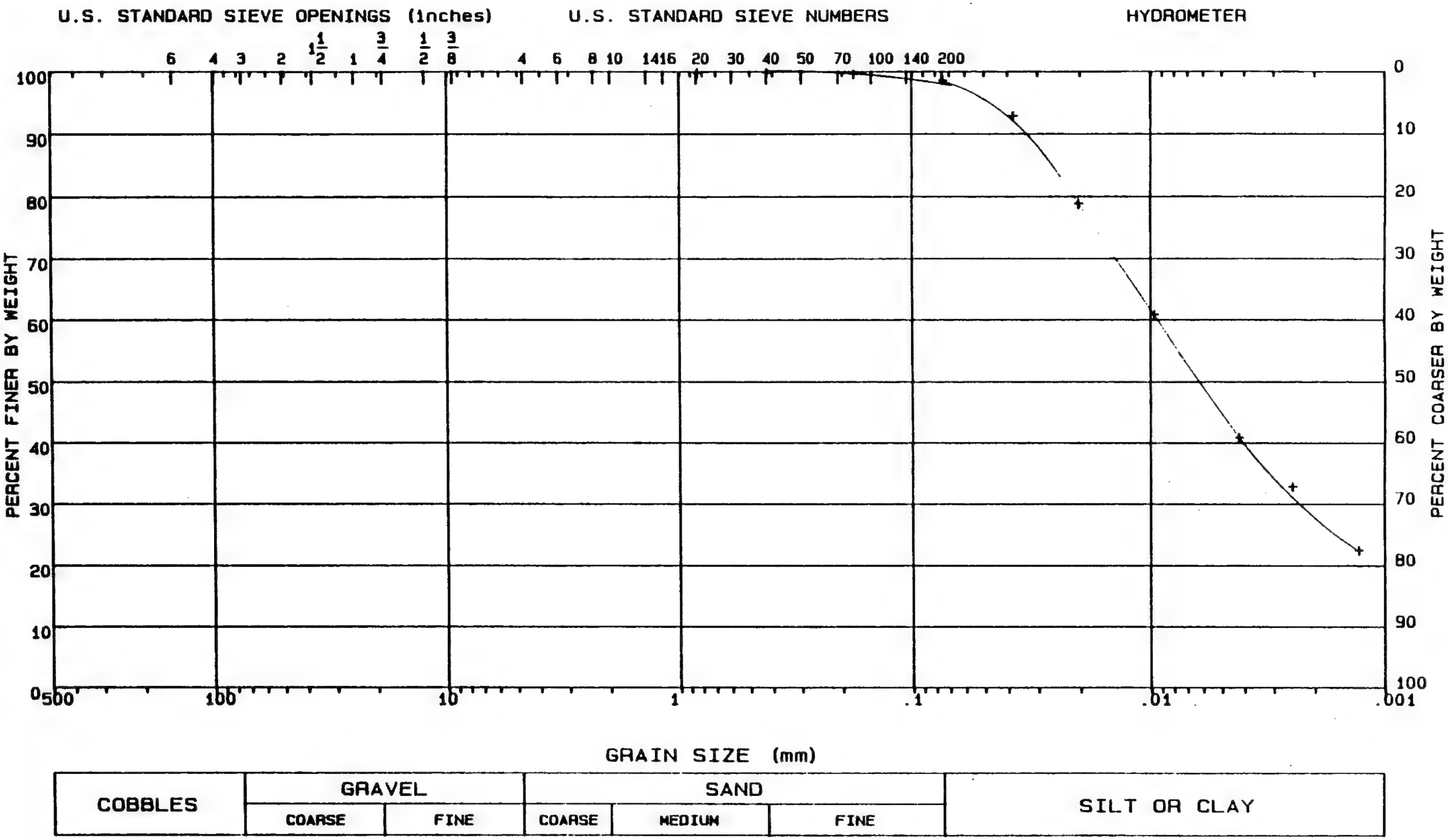
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-126 MU
Sample Number : S-2
Depth : 22'-24'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.025	0.057	1.026	2.330	0.949	0.011
30	0.27	0.081	0.119	1.092	1.458	0.901	0.035
45	0.44	0.119	0.109	1.133	0.915	0.920	0.051
60	0.61	0.097	0.141	1.113	1.449	0.883	0.042
90	0.97	0.093	0.224	1.120	2.412	0.799	0.040
120	1.36	0.263	0.321	1.387	1.223	0.744	0.113
150	1.66	0.587	0.455	2.076	0.775	0.690	0.253
180	2.02	0.735	0.563	2.682	0.767	0.619	0.317
210	2.41	0.804	0.642	3.248	0.799	0.557	0.347
240	2.75	0.855	0.682	3.688	0.798	0.530	0.369
300	3.41	0.919	0.685	3.914	0.746	0.542	0.396
360	4.07	0.962	0.691	4.109	0.718	0.547	0.415
420	4.80	0.984	0.642	3.751	0.653	0.602	0.425
480	5.48	1.007	0.538	3.181	0.535	0.711	0.435
5[illegible]	6.21	1.029	0.485	2.998	0.472	0.770	0.444
6[illegible]	6.97	1.031	0.359	2.608	0.349	0.896	0.445
720	8.35	1.037	0.293	2.467	0.283	0.964	0.447
840	9.84	1.039	0.194	2.289	0.187	1.063	0.449
960	11.25	1.147	1.330	-2.477	1.160	-0.046	0.495
1080	12.64	1.080	0.724	4.918	0.671	0.543	0.466
1200	14.13	1.079	0.777	5.842	0.721	0.490	0.466
1268	15.00	1.077	0.770	5.680	0.715	0.497	0.465
1268	15.00	1.077	0.770	5.680	0.715	0.497	0.465

Table 6 - Triaxial $\bar{R}$ Test Results

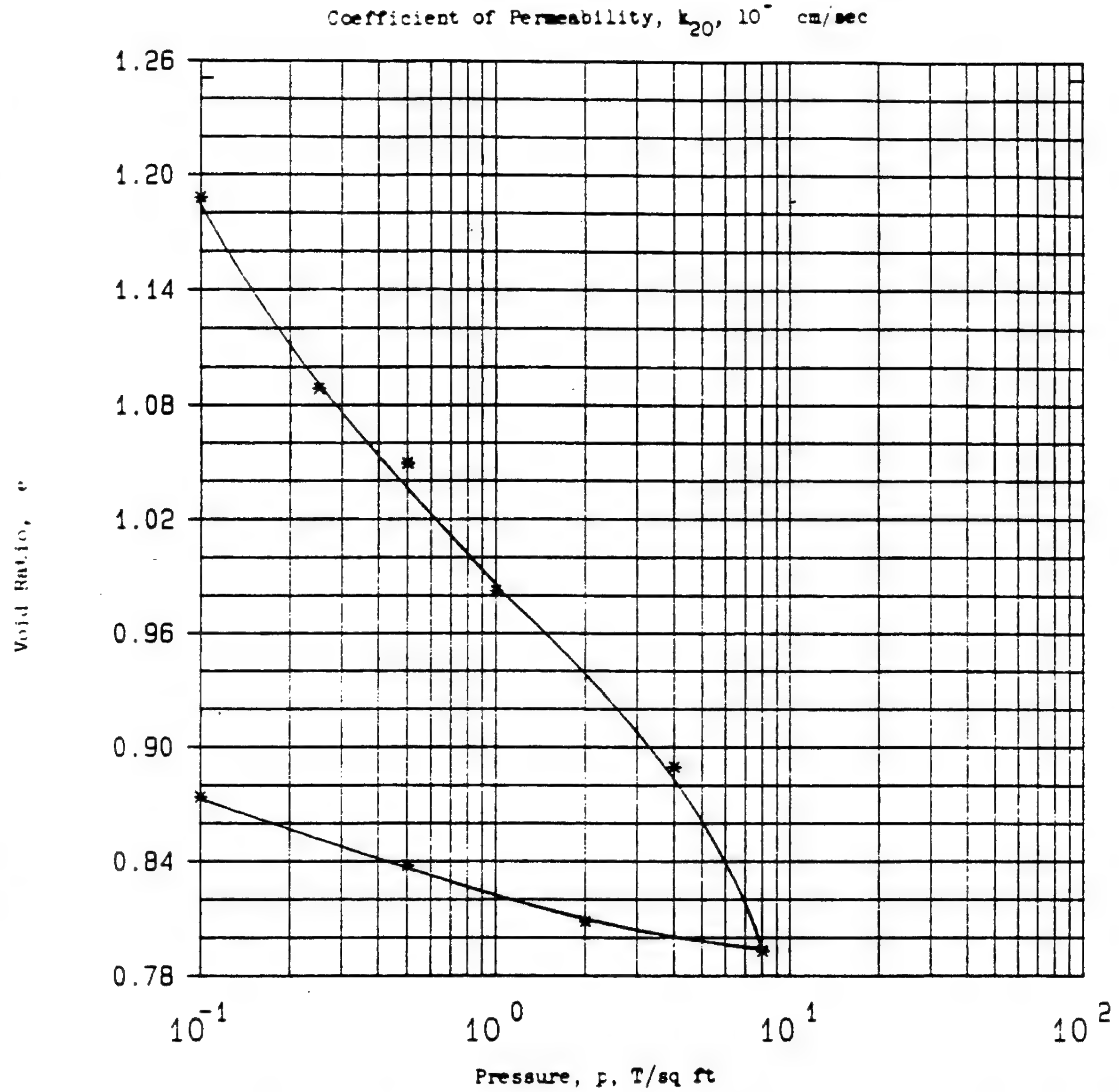
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-126 MU
Sample Number : S-2
Depth : 22'-24'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.420	0.211	1.234	0.502	1.893	0.181
30	0.27	0.733	0.382	1.453	0.521	1.800	0.316
45	0.44	0.897	0.507	1.601	0.565	1.715	0.387
60	0.62	0.986	0.574	1.692	0.582	1.670	0.426
90	0.99	1.145	0.712	1.889	0.622	1.571	0.494
120	1.38	1.246	0.768	2.012	0.617	1.541	0.538
150	1.68	1.331	0.821	2.129	0.617	1.509	0.575
180	2.04	1.359	0.903	2.238	0.665	1.433	0.586
210	2.44	1.403	0.916	2.295	0.653	1.431	0.606
240	2.79	1.449	0.960	2.394	0.663	1.399	0.625
300	3.45	1.504	1.007	2.514	0.670	1.365	0.649
360	4.12	1.557	1.018	2.586	0.654	1.368	0.672
420	4.85	1.590	1.018	2.620	0.641	1.376	0.686
480	5.54	1.606	1.039	2.672	0.648	1.359	0.693
540	6.28	1.638	1.044	2.714	0.638	1.361	0.707
600	7.05	1.650	1.064	2.763	0.645	1.345	0.712
720	8.45	1.695	1.030	2.746	0.608	1.390	0.732
840	9.95	1.700	1.007	2.711	0.593	1.414	0.734
960	11.38	1.706	1.044	2.785	0.613	1.378	0.736
1080	12.79	1.712	1.099	2.899	0.642	1.325	0.739
1200	14.29	1.696	1.095	2.875	0.646	1.325	0.732
1254	15.00	1.695	1.098	2.880	0.648	1.321	0.732
1254	15.00	1.695	1.098	2.880	0.648	1.321	0.732



LL = 67	PL = 23	PI = 44	Gs = 2.69	NAT w = %	PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
CLASSIFICATION Fat clay, CH					BORING NO	89-126 MU
					SAMPLE NO.	S-2
					DEPTH/ELEV	22'-24'
GRADATION CURVE					MRD LAB NO.	90/135

FIGURE 12

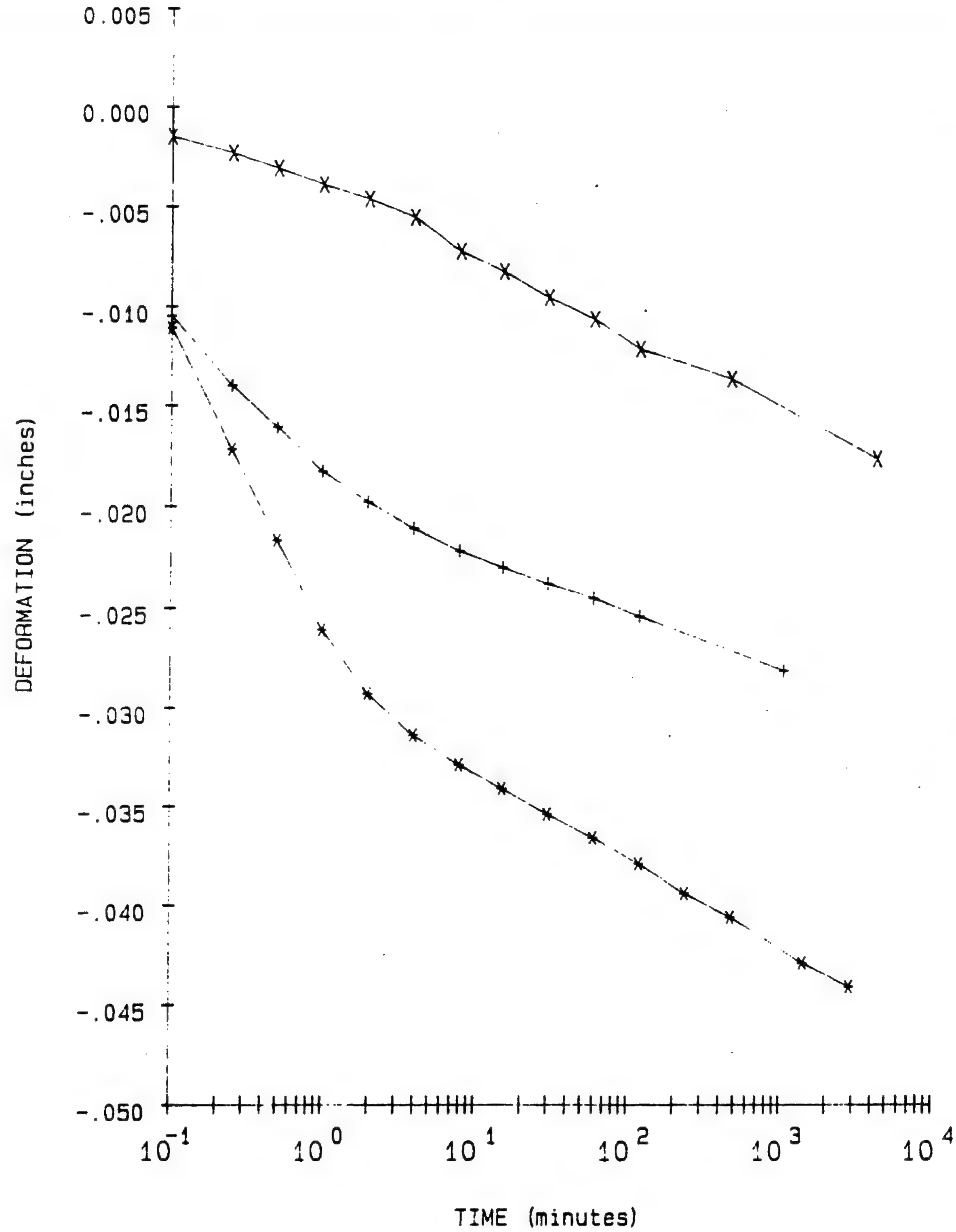


Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.3 in.	Ht 1 in.	Water Content, w_o	49.7 %	w_f	35.3 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.25	e_f	0.87
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	100 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	71.2 lb/ft^3		
Classification Fat clay, CH		k_{20} at e_o = x 10^{-} cm/sec			
LL 63	G_s 2.57	Project	MINNESOTA RIVER; IA-90-04-ED-GH		
PL 33	D_{10}				

Remarks Dark gray. Torvane=0.30TSF.	Area	MRD LAB NO. 90/135	
Slightly orgainic calcareous.	Boring No. 89-130 MU	Sample No. S-1	
	Depth El 4'-6'	Date	
	CONSOLIDATION TEST REPORT		

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE

Figure 1



LEGEND

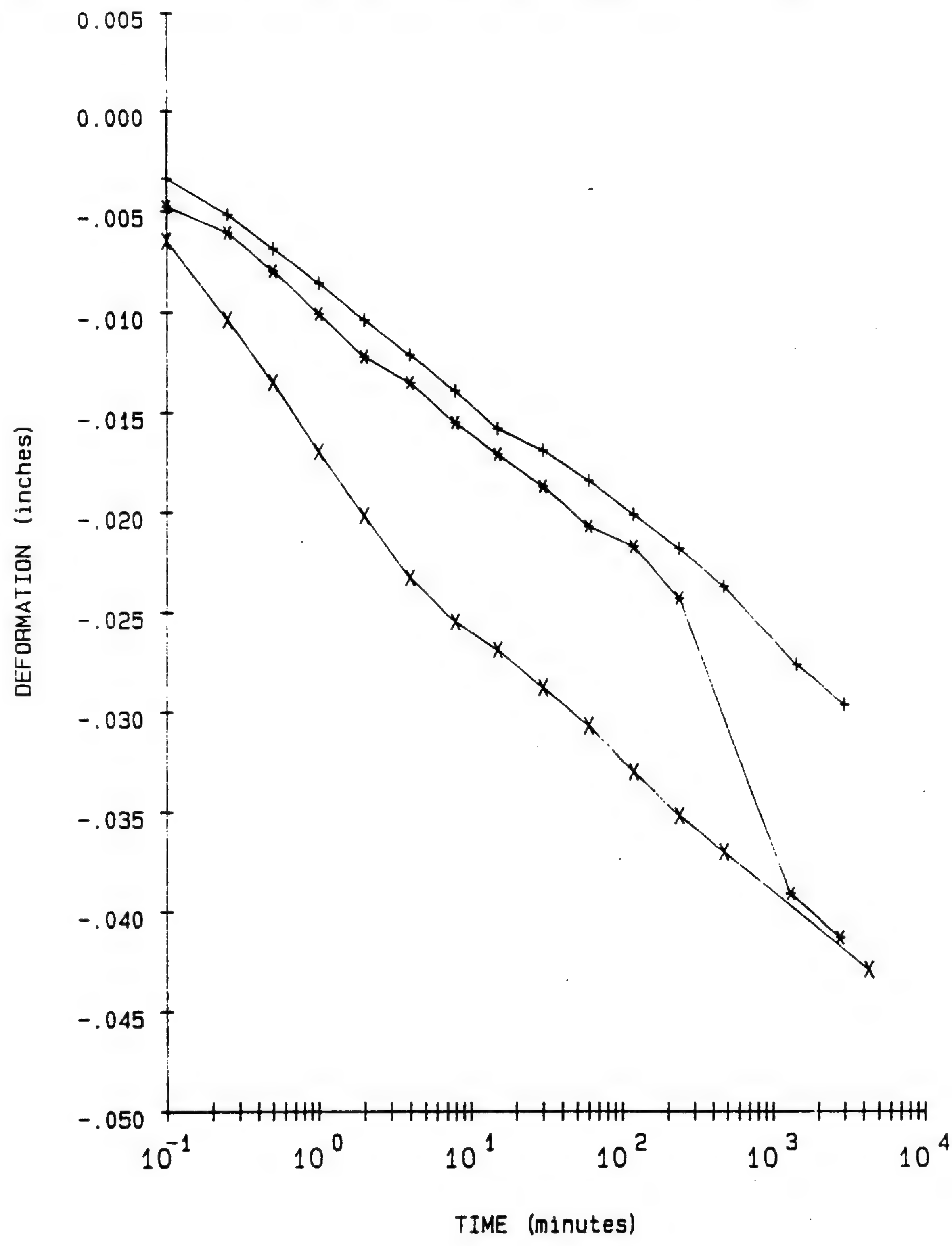
+ = .1 TSF

* = .25 TSF

X = .5 TSF

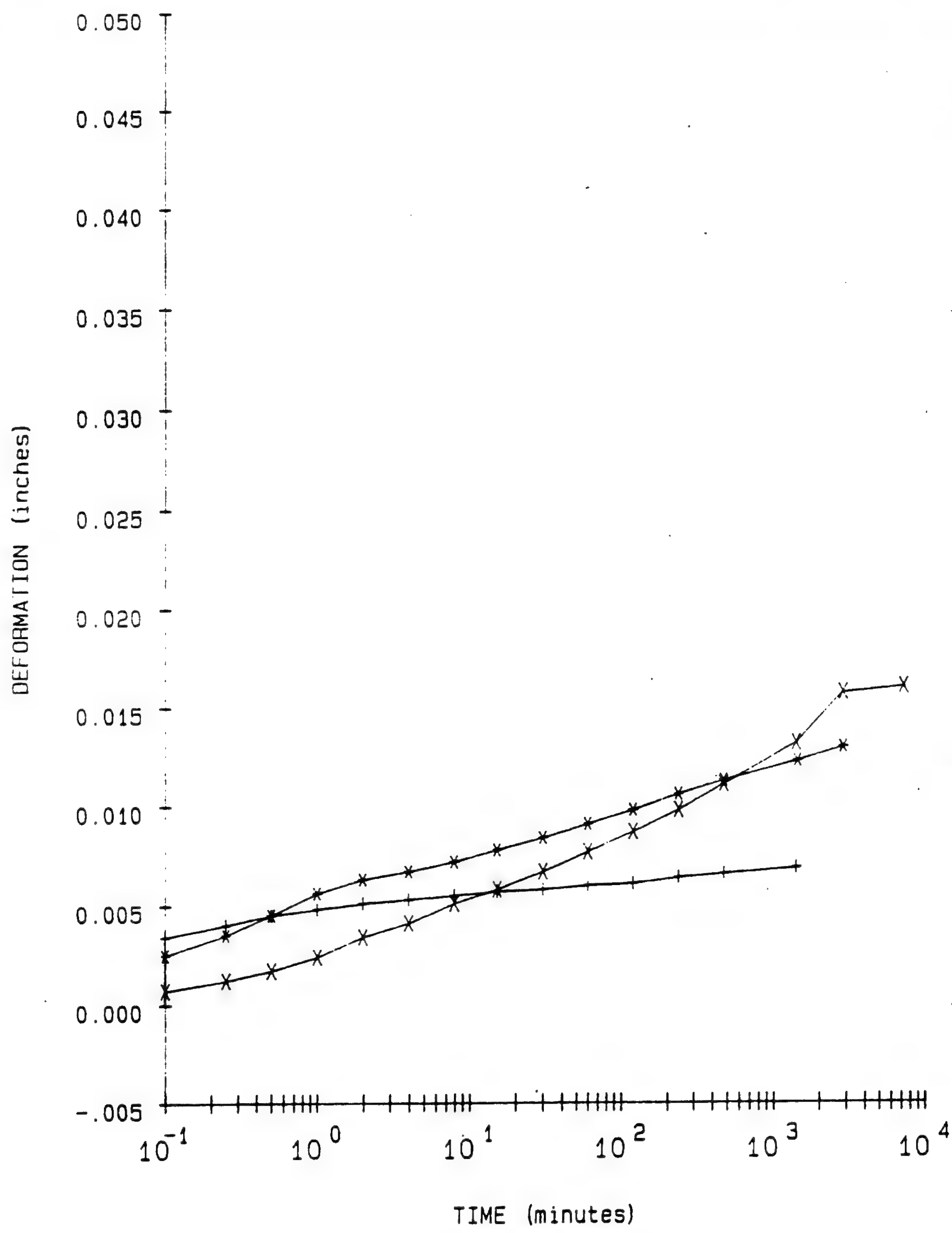
PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-1
DEPTH/ELEV	4'-6'
MRD LAB NO.	90/135

FIGURE 2



LEGEND		
+ = 2 TSF	PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
✱ = 4 TSF	BORING NO.	89-130 MU
X = 8 TSF	SAMPLE NO.	S-1
	DEPTH/ELEV	4'-6'
	MRD LAB NO.	90/135

FIGURE 3



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-1
DEPTH/ELEV	4'-6'
MRD LAB NO.	90/135

FIGURE 4

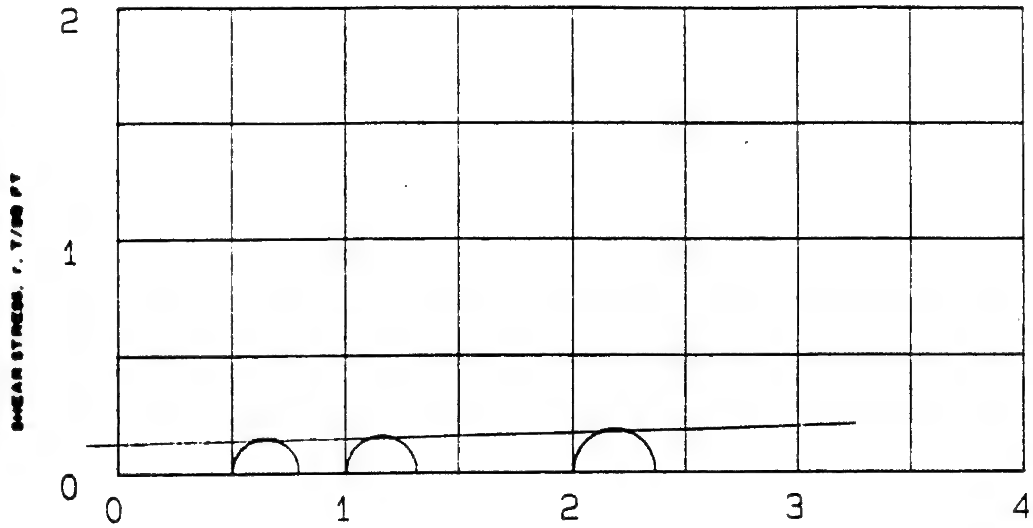
Consolidation Test Data

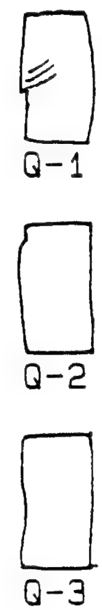
Project	MINNESOTA RIVER; IA-90-04-ED-GH
Boring No.	89-130 MU
Sample No.	S-1
Depth/Elev	4'-6'
MRD Lab No.	90/135

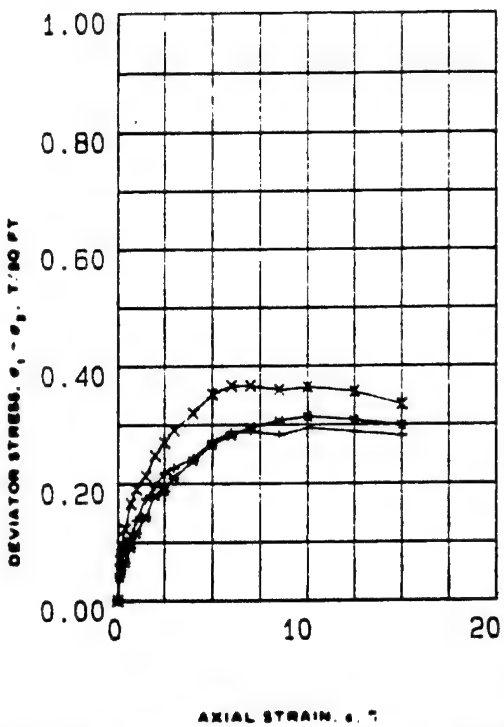
Gs = 2.57
eo = 1.251
0.42eo = 0.525

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
49.7	269.6	71.2	1.251		100.0
35.3	269.6	73.3	1.188	0.10	76.5
35.3	269.6	76.8	1.088	0.25	83.5
35.3	269.6	78.3	1.049	0.50	86.6
35.3	269.6	80.9	0.982	2.00	92.5
35.3	269.6	84.9	0.889	4.00	100.0
35.3	269.6	89.5	0.793	8.00	100.0
35.3	269.6	88.7	0.808	2.00	100.0
5.3	269.6	87.3	0.837	0.50	100.0
5.3	269.6	85.6	0.874	0.10	100.0

Axial Strain (%)	Void Ratio
1	1.228
2	1.206
3	1.183
4	1.161
5	1.138
6	1.116
7	1.093
8	1.071
9	1.048
10	1.026
11	1.003
12	0.981
13	0.958
14	0.936
15	0.913
16	0.891
17	0.868
18	0.846
19	0.823
20	0.801







NORMAL STRESS, σ, T/SQ FT

			SPECIMEN NO	1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	52.5	49.7	49.2	
	DRY DENSITY LB/CU FT	γd_o	70.4	71.6	72.2	
	SATURATION %	S_o	100.0	100.0	100.0	
	VOID RATIO	e_o	1.28	1.24	1.22	
BEFORE SHEAR	WATER CONTENT, %	w_c	52.5	49.6	49.0	
	DRY DENSITY LB/CU FT	γd_c	70.4	71.6	72.2	
	SATURATION, %	S_c	100.0	100.0	100.0	
	VOID RATIO	e_c	1.28	1.24	1.22	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.29	0.31	0.37	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	21.0	21.0	14.8	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.28	0.30	0.33	
INITIAL DIAMETER IN.		D_o	1.39	1.40	1.40	
INITIAL HEIGHT, IN.		H_o	2.97	2.97	2.97	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH

LL 63	PL 33	PI 30	G_s 2.57	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Dark gray. Torvane=0.30 TSF.
Slightly organic calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

BORING NO 89-130 MU SAMPLE NO. S-1

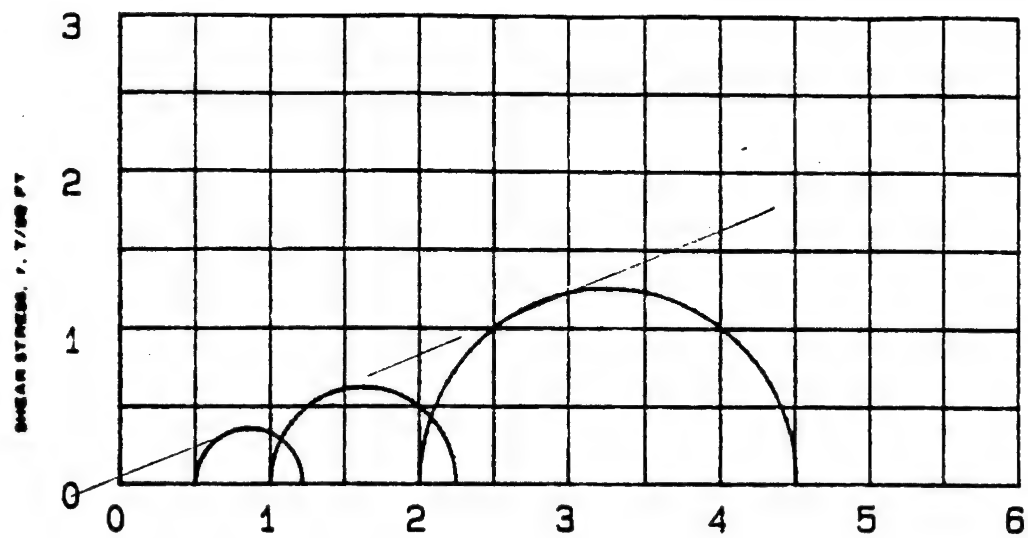
DEPTH ELEV 4'-6'

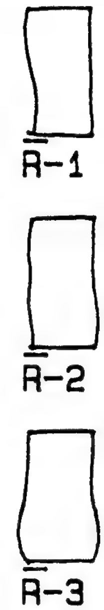
LABORATORY 90/135 DATE

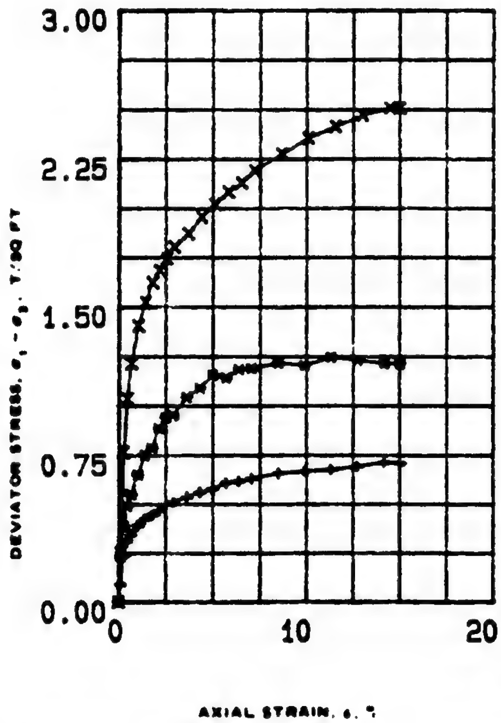
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 5

Figure C-494







SPECIMEN NO			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	47.6	57.4	42.8	
	DRY DENSITY LB/CU FT	γ_{d_o}	71.1	72.2	74	
	SATURATION %	S_o	97	100	94	
	VOID RATIO	e_o	1.26	1.22	1.17	
BEFORE SHEAR	WATER CONTENT, %	w_c	49.5	51.3	42.8	
	DRY DENSITY LB/CU FT	γ_{d_c}	74.1	76.1	82.9	
	SATURATION %	S_c	100	100	100	
	VOID RATIO	e_c	1.16	1.11	.94	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	6.263	4.103	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.716	1.246	2.508	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_1	1200	960	1200	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.710	1.213	2.508	
INITIAL DIAMETER, IN.		D_o	1.39	1.34	1.42	
INITIAL HEIGHT, IN.		H_o	2.97	2.98	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH B-Value 1.0 1.0 1.0

LL 63	PL 33	PI 30	G_s 2.57	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Dark gray. Torvane=0.30 TSF
Slightly organic calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-6H

BORING NO 89-130 MU SAMPLE NO. S-1

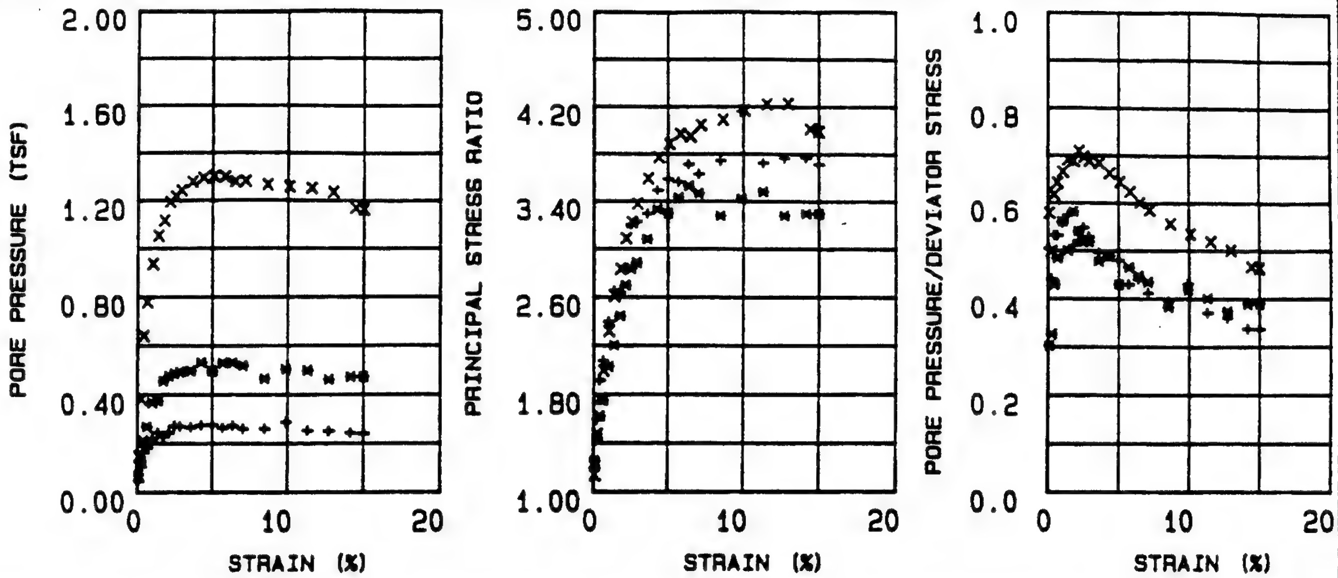
DEPTH ELEV 4'-6'

LABORATORY 90/135 DATE

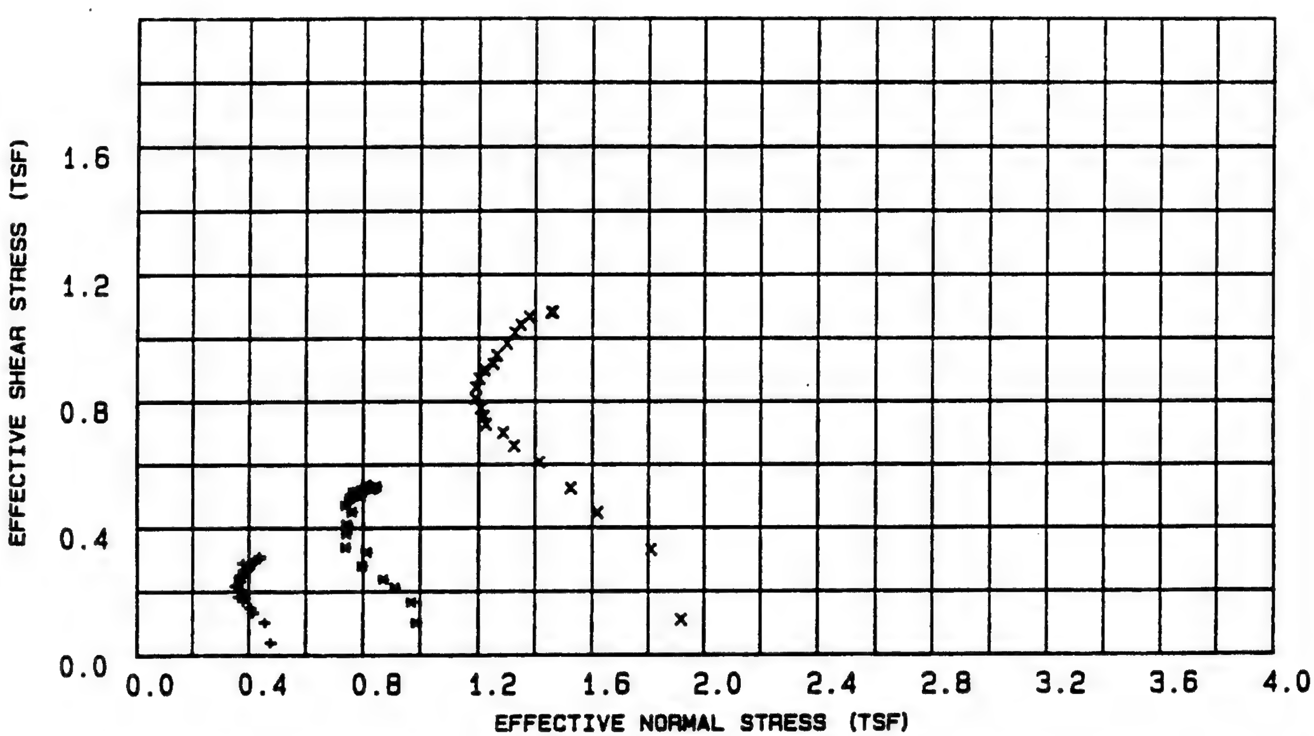
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 6



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF

✖ = 1 TSF

X = 2 TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-1
DEPTH/ELEV	4'-6'
MRD LAB NO.	90/135

FIGURE 7

Figure C-496

Table 1 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-130 MU
Sample Number : S-1
Depth : 4'-6'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.089	0.045	1.196	0.504	0.477	0.038
30	0.27	0.236	0.104	1.594	0.440	0.454	0.102
45	0.44	0.308	0.163	1.914	0.532	0.413	0.133
60	0.66	0.342	0.181	2.073	0.531	0.404	0.148
90	1.02	0.392	0.219	2.396	0.558	0.378	0.169
120	1.38	0.424	0.243	2.653	0.574	0.362	0.183
150	1.77	0.446	0.227	2.637	0.510	0.383	0.193
180	2.13	0.468	0.243	2.826	0.520	0.373	0.202
210	2.50	0.500	0.273	3.203	0.548	0.351	0.216
240	2.88	0.512	0.270	3.227	0.528	0.357	0.221
300	3.59	0.538	0.266	3.295	0.495	0.367	0.232
360	4.29	0.562	0.274	3.493	0.488	0.365	0.243
420	4.99	0.578	0.276	3.586	0.479	0.367	0.250
480	5.69	0.611	0.262	3.562	0.429	0.389	0.264
540	6.37	0.618	0.272	3.711	0.441	0.381	0.267
600	7.05	0.632	0.259	3.628	0.411	0.398	0.273
[illegible]	8.48	0.660	0.259	3.743	0.394	0.404	0.285
840	9.89	0.670	0.288	4.162	0.431	0.378	0.289
960	11.32	0.678	0.251	3.722	0.370	0.417	0.293
1080	12.72	0.694	0.249	3.763	0.359	0.423	0.300
1200	14.15	0.716	0.241	3.769	0.337	0.436	0.309
1267	15.00	0.710	0.238	3.712	0.336	0.437	0.306

Table 2 - Triaxial $\overline{R}$ Test Results

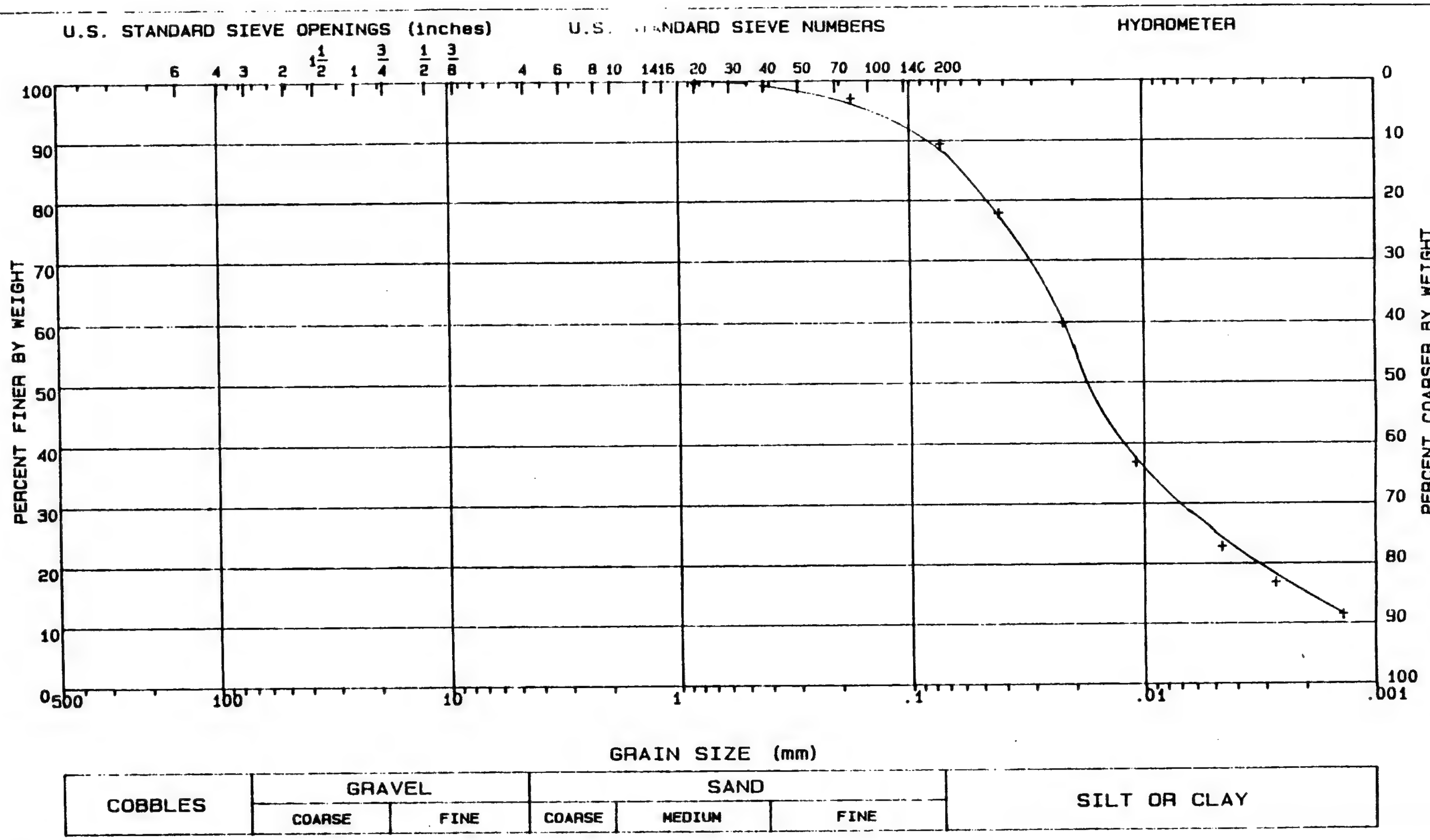
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-130 MU
Sample Number : S-1
Depth : 4'-6'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.234	0.071	1.252	0.302	0.987	0.101
30	0.27	0.386	0.126	1.441	0.326	0.969	0.166
45	0.44	0.490	0.210	1.621	0.429	0.911	0.212
60	0.66	0.551	0.267	1.752	0.484	0.870	0.238
90	1.02	0.651	0.365	2.025	0.561	0.796	0.281
120	1.38	0.752	0.375	2.203	0.500	0.811	0.324
150	1.77	0.785	0.456	2.444	0.582	0.738	0.339
180	2.13	0.886	0.478	2.698	0.540	0.741	0.382
210	2.50	0.942	0.487	2.837	0.518	0.746	0.406
240	2.88	0.955	0.494	2.888	0.518	0.742	0.412
300	3.59	1.045	0.498	3.080	0.477	0.761	0.451
360	4.29	1.092	0.532	3.333	0.488	0.738	0.471
420	4.99	1.158	0.496	3.297	0.429	0.791	0.500
480	5.70	1.142	0.530	3.432	0.465	0.753	0.493
540	6.38	1.187	0.530	3.528	0.447	0.764	0.513
[illegible]	7.05	1.192	0.517	3.465	0.434	0.778	0.514
720	8.48	1.218	0.465	3.276	0.382	0.836	0.526
840	9.89	1.204	0.503	3.421	0.418	0.795	0.520
960	11.32	1.246	0.498	3.480	0.400	0.810	0.538
1080	12.73	1.230	0.460	3.277	0.374	0.845	0.531
1200	14.16	1.213	0.472	3.297	0.389	0.828	0.524
1267	15.00	1.213	0.472	3.296	0.390	0.828	0.523

Table 3 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-130 MU
Sample Number : S-1
Depth : 4'-6'
Confining Pressure : 2 TSF

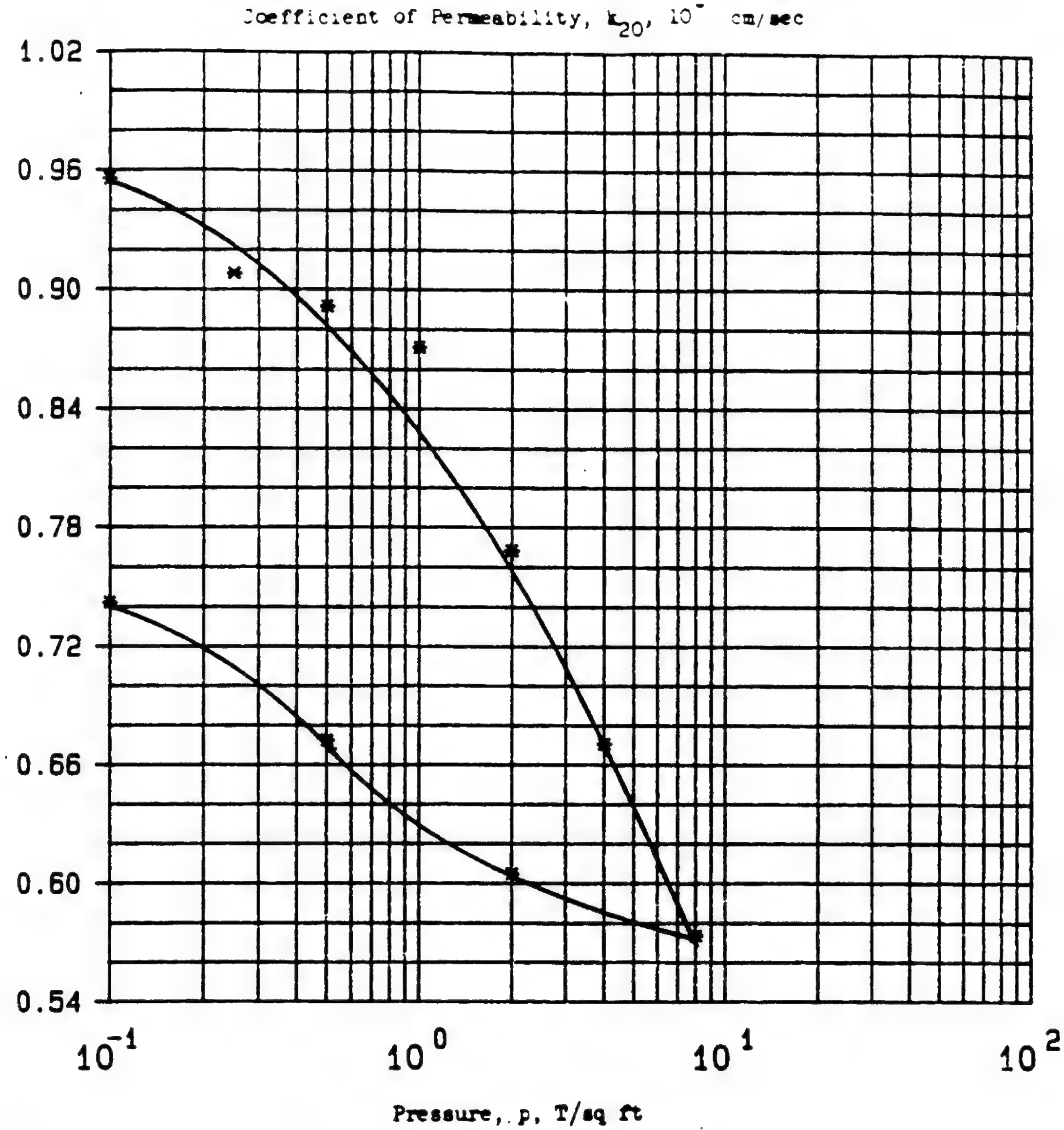
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.253	0.146	1.136	0.578	1.917	0.109
30	0.27	0.764	0.380	1.472	0.498	1.809	0.330
45	0.45	1.036	0.639	1.761	0.617	1.617	0.447
60	0.67	1.214	0.778	1.994	0.642	1.523	0.524
90	1.04	1.406	0.935	2.319	0.665	1.413	0.607
120	1.41	1.523	1.052	2.607	0.691	1.325	0.658
150	1.80	1.622	1.115	2.832	0.688	1.286	0.700
180	2.18	1.683	1.193	3.086	0.709	1.224	0.727
210	2.55	1.745	1.216	3.224	0.697	1.216	0.753
240	2.94	1.805	1.241	3.378	0.688	1.206	0.779
300	3.66	1.872	1.277	3.590	0.683	1.187	0.808
360	4.38	1.956	1.294	3.769	0.662	1.190	0.844
420	5.09	2.021	1.300	3.885	0.644	1.200	0.872
480	5.81	2.084	1.298	3.970	0.623	1.218	0.900
540	6.50	2.130	1.277	3.947	0.600	1.250	0.919
[illegible]	7.20	2.192	1.280	4.045	0.585	1.263	0.946
[illegible]	8.66	2.276	1.264	4.090	0.556	1.299	0.982
840	10.09	2.356	1.256	4.167	0.534	1.327	1.017
960	11.55	2.415	1.250	4.221	0.518	1.348	1.042
1080	12.98	2.472	1.234	4.225	0.500	1.378	1.067
1200	14.44	2.508	1.167	4.013	0.466	1.454	1.082
1243	15.00	2.508	~~1.161~~	3.989	0.463	1.461	1.082



LL = 63	PL = 33	PI = 30	Gs = 2.57	NAT w = %	PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
CLASSIFICATION Fat clay, CH					BORING NO.	89-130 MU
					SAMPLE NO.	S-1
					DEPTH/ELEV	4'-6'
GRADATION CURVE					MRD LAB NO.	90/135

FIGURE 8

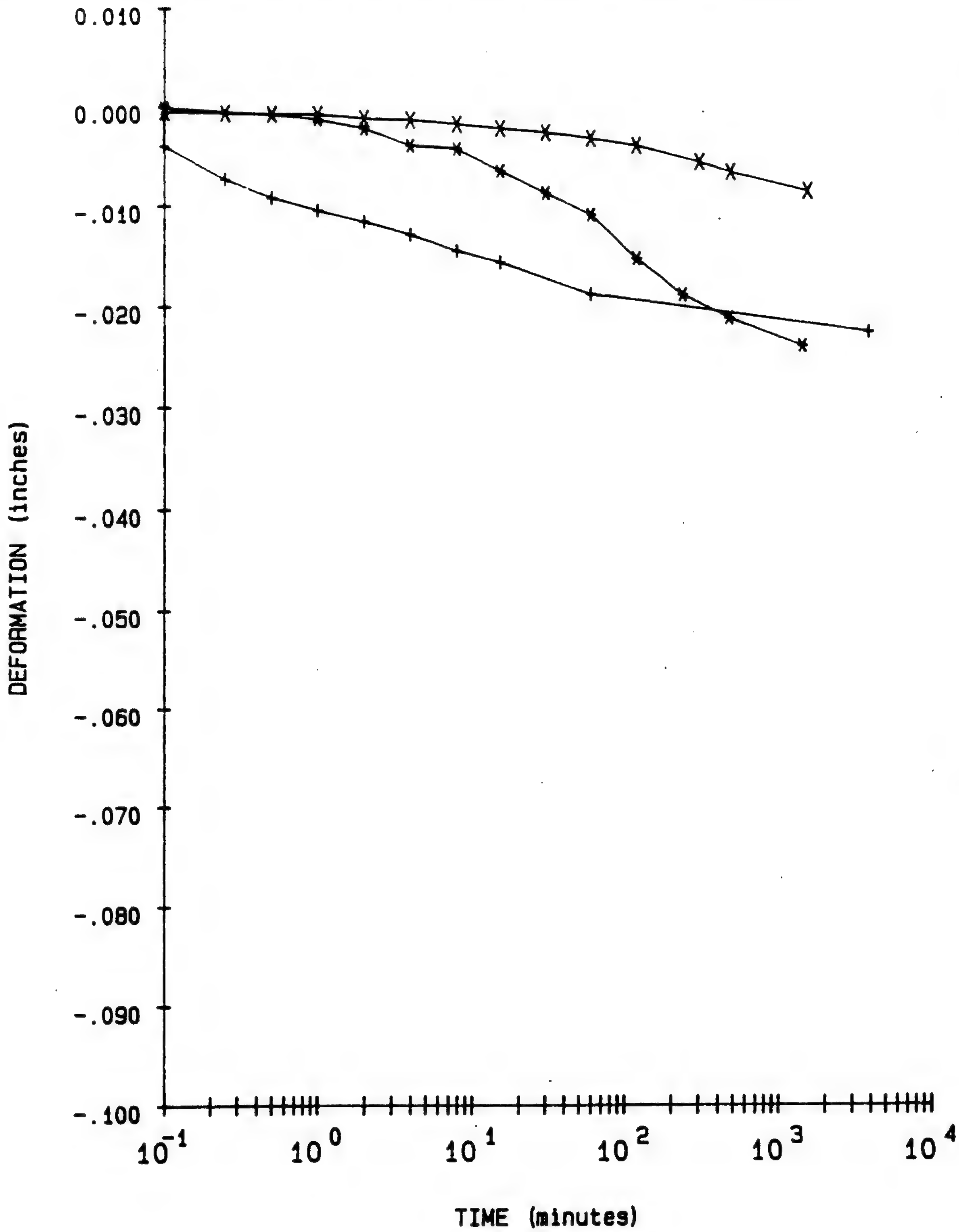
Figure C-500



Type of Specimen	UNDISTURBED			Before Test		After Test	
Diam 4.3 in.		Ht 1 in.		Water Content, w_o	37.4 %	w_f	24.2 %
Overburden Pressure, p_o			T/sq ft	Void Ratio, e_o	1.00	e_f	0.74
Preconsol. Pressure, p_c			T/sq ft	Saturation, S_o	99 %	S_f	86 %
Compression Index, C_c				Dry Density, γ_d	82.7 lb/ft^3		
Classification	Sandy clay, CL			k_{20} at e_o =	x 10^{-} cm/sec		
LL 41		G_s 2.65		Project	MINNESOTA RIVER; IA-90-04-ED-GH		
PL 14		D_{10}					
Remarks Dark gray. Torvane=0.30TSF				Area	MRD LAB NO. 90/135		
Organic. Non-calcareous.				Boring No.	89-130 MU	Sample No.	S-2
				Depth El	10'-12'	Date	
				CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

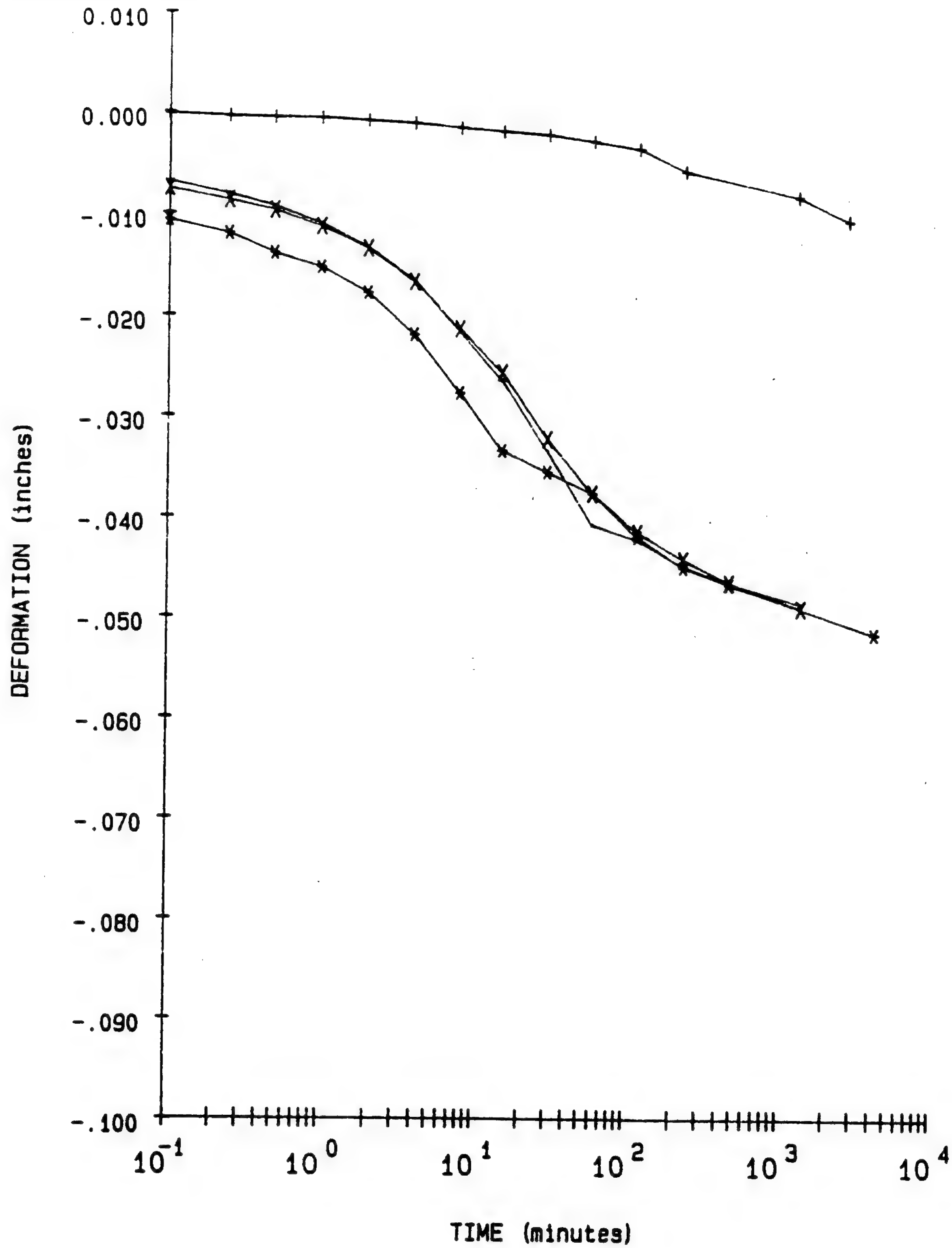
Figure 1



LEGEND	PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
+ = .1 TSF		
* = .25 TSF	BORING NO.	89-130 MU
X = .5 TSF	SAMPLE NO.	S-2
	DEPTH/ELEV	10'-12'
	MRD LAB NO.	90/135

FIGURE 2

Figure C-502



LEGEND

+ = 1 TSF

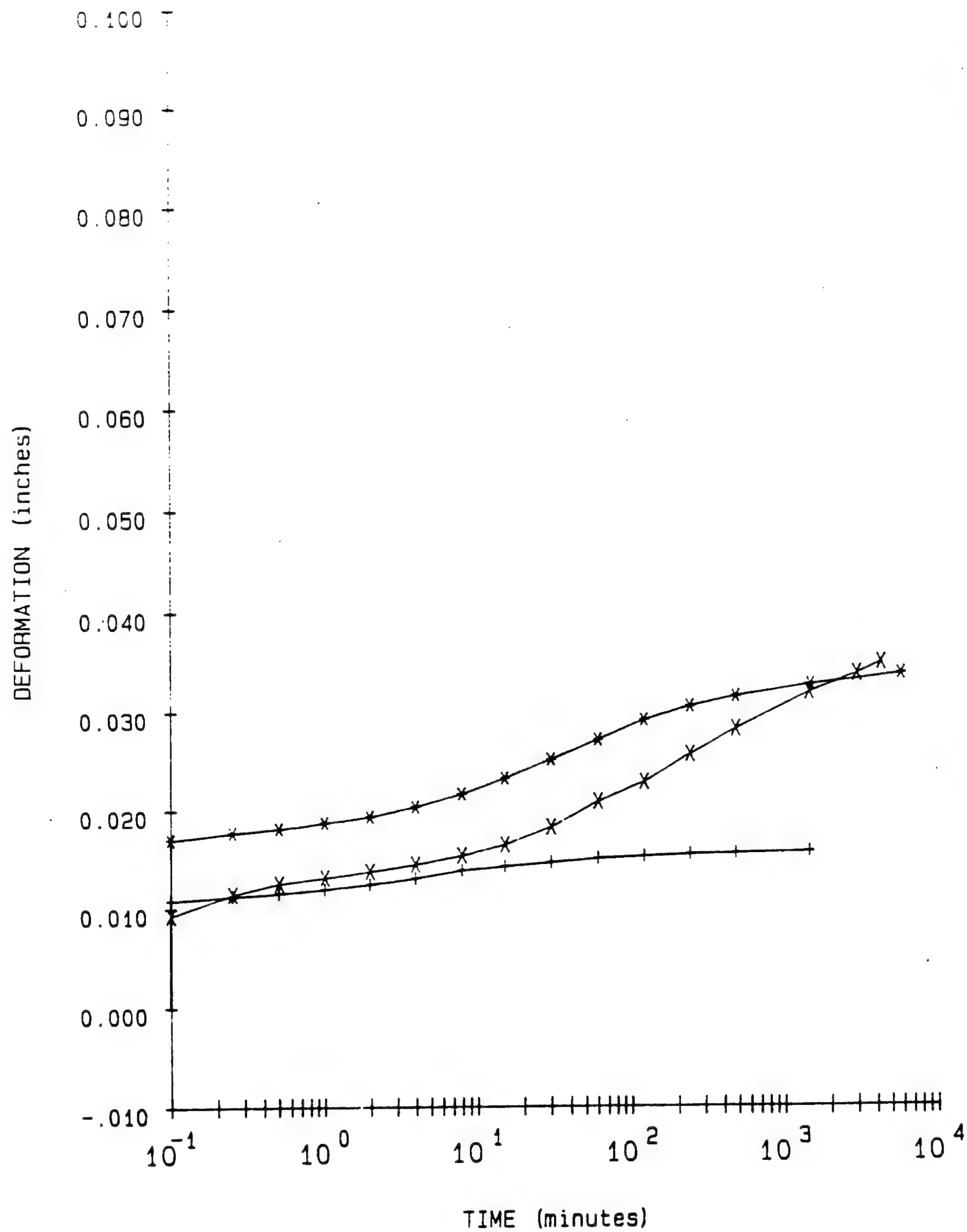
* = 2 TSF

X = 4 TSF

- = 8 TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-2
DEPTH/ELEV	10'-12'
MRD LAB NO.	90/135

FIGURE 3



LEGEND	
+ = 2	TSF Rebound
* = .5	TSF Rebound
X = .1	TSF Rebound

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-2
DEPTH/ELEV	10'-12'
MRD LAB NO.	90/135

FIGURE 4

Consolidation Test Data

Project MINNESOTA RIVER; IA-90-04-ED-GH

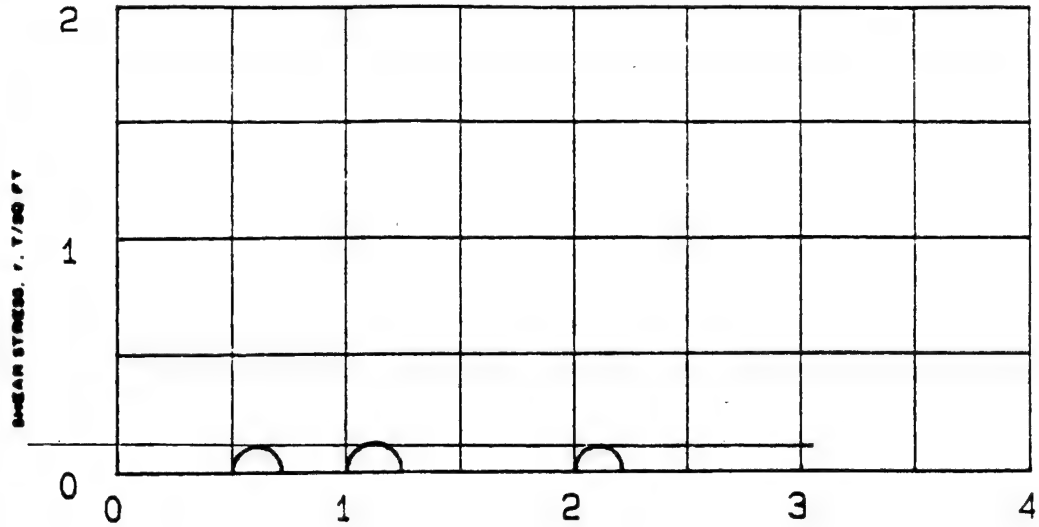
Boring No. 89-130 MU
Sample No. S-2
Depth/Elev 10'-12'
MRD Lab No. 90/135

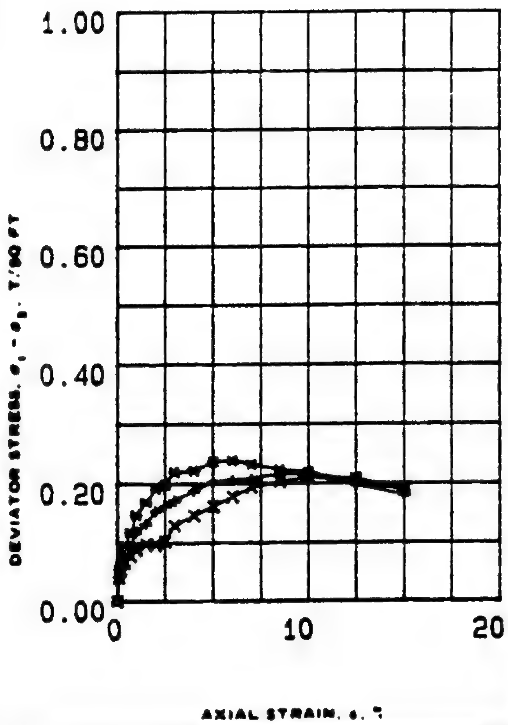
Gs = 2.65
eo = 1.000
0.42eo = 0.420

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
37.4	310.7	82.7	1.000		99.0
24.2	310.7	84.6	0.956	0.10	67.2
24.2	310.7	86.7	0.908	0.25	70.7
24.2	310.7	87.4	0.891	0.50	72.0
24.2	310.7	88.4	0.871	1.00	73.7
24.2	310.7	93.5	0.768	2.00	83.6
24.2	310.7	99.0	0.670	4.00	95.8
[illegible].2	310.7	105.1	0.573	8.00	100.0
[illegible]4.2	310.7	103.0	0.605	2.00	100.0
24.2	310.7	98.9	0.672	0.50	95.5
24.2	310.7	94.9	0.742	0.10	86.5

Axial Strain (%)	Void Ratio
1	0.980
2	0.960
3	0.940
4	0.920
5	0.900
6	0.880
7	0.860
8	0.840
9	0.820
10	0.800
11	0.780
12	0.760
13	0.740
14	0.720
15	0.700
16	0.680
17	0.660
18	0.640
19	0.620
20	0.600

Figure C-505





SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	34.8	34.9	36.5	
	DRY DENSITY, LB/CU FT	γ_{d_o}	88.5	86.5	83.2	
	SATURATION, %	S_o	100.0	100.0	98.0	
	VOID RATIO	e_o	0.87	0.91	0.99	
BEFORE SHEAR	WATER CONTENT, %	w_c	34.4	34.5	36.5	
	DRY DENSITY, LB/CU FT	γ_{d_c}	88.5	88.5	83.4	
	SATURATION, %	S_c	100.0	100.0	98.0	
	VOID RATIO	e_c	0.87	0.91	0.98	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.22	0.24	0.21	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	18.5	12.8	20.3	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.18	0.19	0.19	
INITIAL DIAMETER, IN.		D_o	1.39	1.41	1.39	
INITIAL HEIGHT, IN.		H_o	2.99	2.98	2.95	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CL

LL 41 | PL 14 | PI | G_s 2.65

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST Q

REMARKS: Dark gray. Torvane=0.30 TSF. Organic. Non-calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

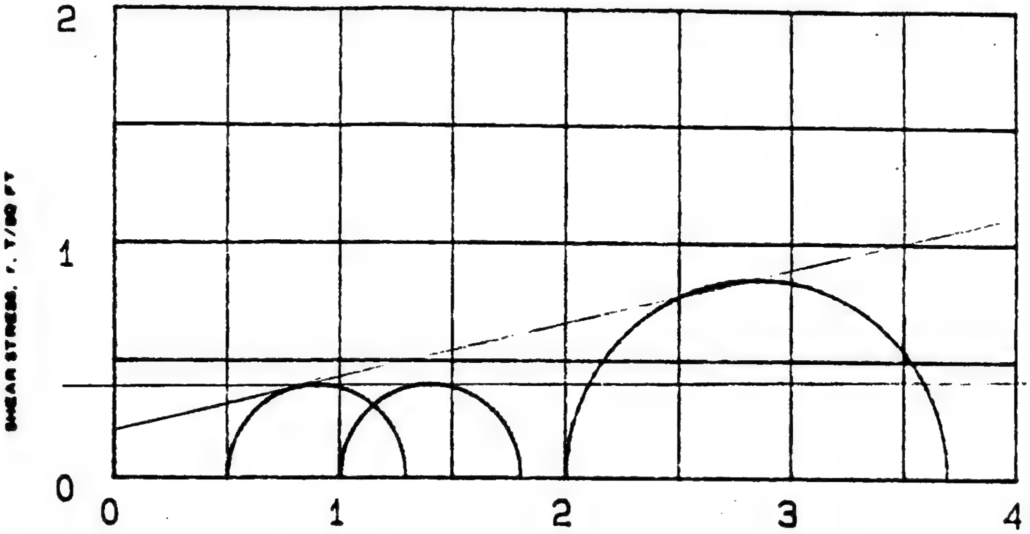
BORING NO 89-130 MU | SAMPLE NO. S-2

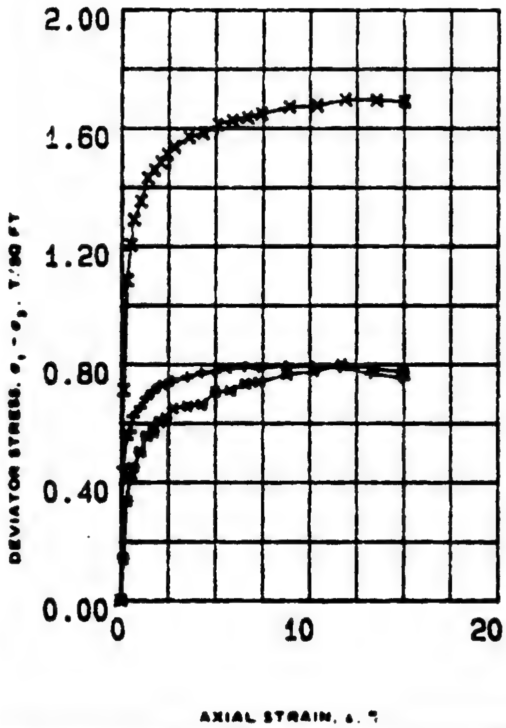
DEPTH ELEV 10'-12'

LABORATORY 90/135 | DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 5





SPECIMEN NO			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	32.8	30.2	31.2	
	DRY DENSITY LB/CU FT	γ_{d_o}	88.2	92.9	92.4	
	SATURATION, %	S_o	99	100	100	
	VOID RATIO	e_o	.88	.78	.79	
BEFORE SHEAR	WATER CONTENT, %	w_c	30.4	28.4	24.8	
	DRY DENSITY LB/CU FT	γ_{d_c}	91.7	97.8	100.9	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.8	.69	.64	
	FINAL BACK PRESSURE, T/SQ FT	u_b	5.543	5.543	5.543	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.793	0.800	1.896	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	720	960	960	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.760	0.771	1.889	
INITIAL DIAMETER IN.		D_o	1.4	1.4	1.41	
INITIAL HEIGHT, IN.		H_o	2.97	2.97	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CL B-Value 1.0 1.0 1.0

LL 41	PL 14	PI 27	G_s 2.65

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST RBAR

REMARKS: Dark gray. Torvane=0.30 TSF. Organic. Non-calcareous. All 3 specimens were rerun as shown due to data acquisition problem with first set.

PROJECT MINNESOTA RIVER; IA-90-04-ED-8H

BORING NO 89-130 MU | SAMPLE NO. S-2

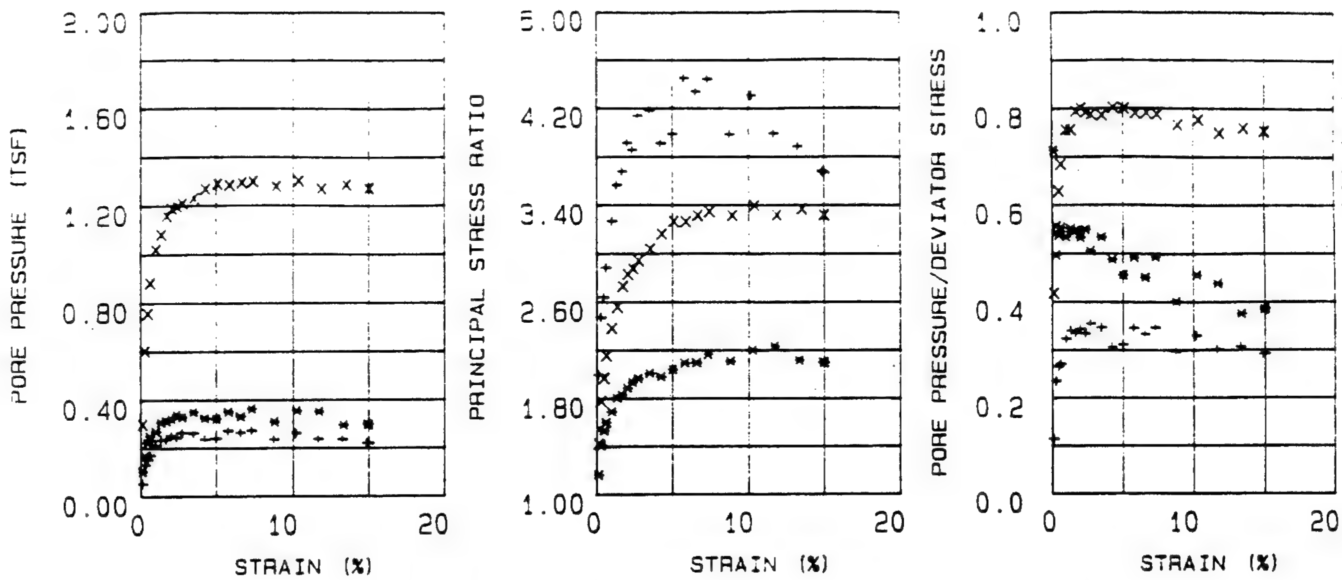
DEPTH ELEV 10'-12'

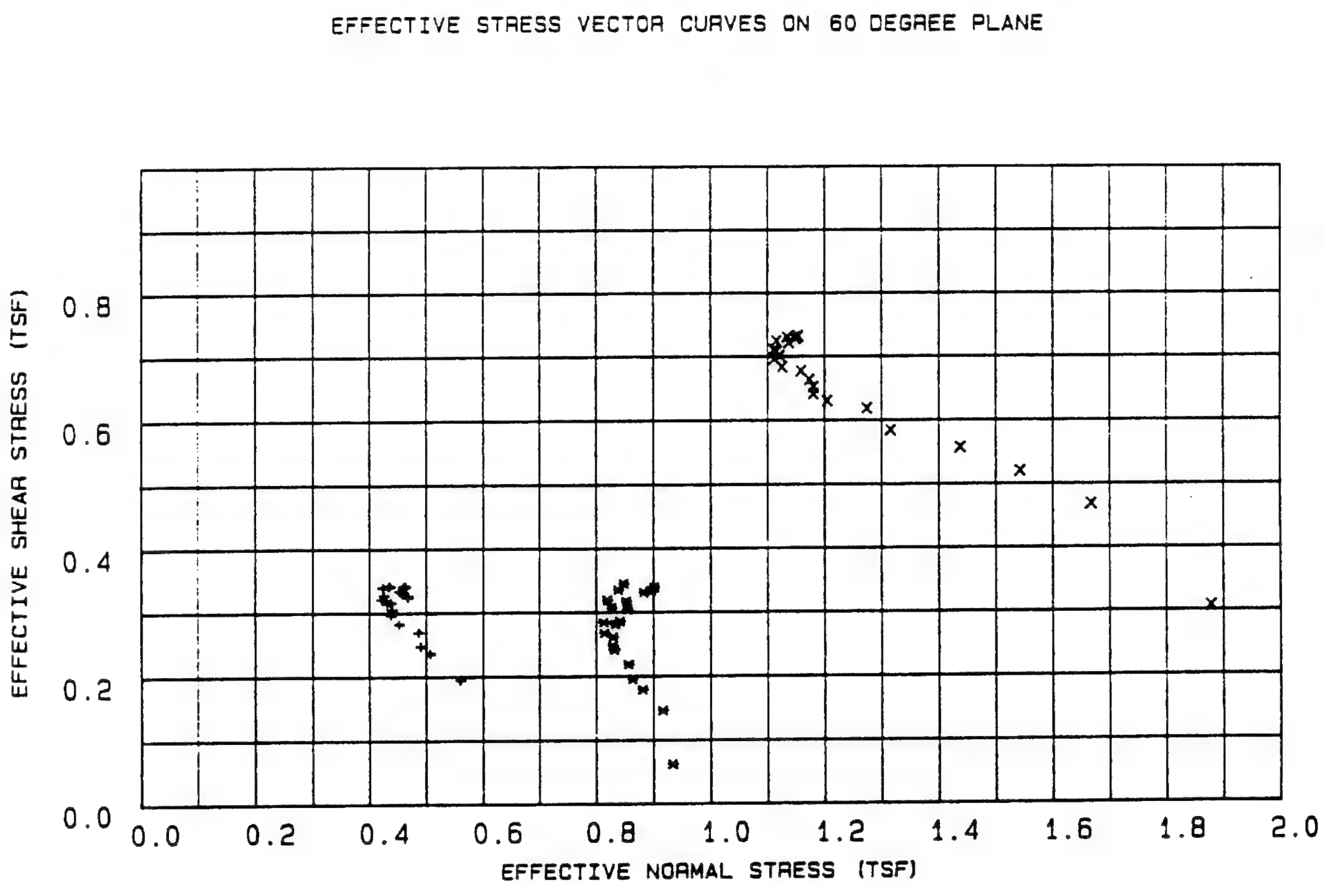
LABORATORY 90/135 | DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 6





LEGEND

+ = .5 TSF

✱ = 1 TSF

X = 2 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-2
DEPTH/ELEV	10'-12'
MRD LAB NO.	90/135

FIGURE 7

Figure C-508

R

Table 1 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-130 MU
Sample Number : S-2
Depth : 10'-12'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.449	0.051	1.999	0.114	0.560	0.194
30	0.29	0.547	0.129	2.473	0.236	0.506	0.236
45	0.48	0.571	0.152	2.640	0.266	0.489	0.247
60	0.63	0.624	0.169	2.885	0.271	0.485	0.269
90	1.00	0.654	0.211	3.266	0.323	0.451	0.282
120	1.33	0.685	0.233	3.566	0.340	0.437	0.296
150	1.67	0.707	0.236	3.679	0.335	0.439	0.305
180	2.01	0.728	0.250	3.916	0.344	0.430	0.314
210	2.35	0.732	0.244	3.855	0.334	0.437	0.316
240	2.71	0.743	0.263	4.139	0.355	0.421	0.321
300	3.47	0.757	0.262	4.183	0.347	0.425	0.327
360	4.22	0.771	0.235	3.909	0.305	0.456	0.333
420	4.97	0.775	0.240	3.986	0.311	0.452	0.334
[illegible]80	5.74	0.787	0.272	4.451	0.346	0.423	0.340
[illegible]	6.52	0.791	0.263	4.339	0.333	0.433	0.341
600	7.27	0.786	0.272	4.444	0.347	0.423	0.339
720	8.73	0.793	0.234	3.981	0.296	0.462	0.342
840	10.18	0.791	0.261	4.311	0.330	0.435	0.342
960	11.63	0.789	0.236	3.989	0.300	0.459	0.340
1080	13.25	0.767	0.234	3.882	0.306	0.456	0.331
1200	14.83	0.753	0.219	3.678	0.291	0.467	0.325
1213	15.00	0.750	0.219	3.666	0.292	0.466	0.324

Table 2 - Triaxial $\bar{R}$ Test Results

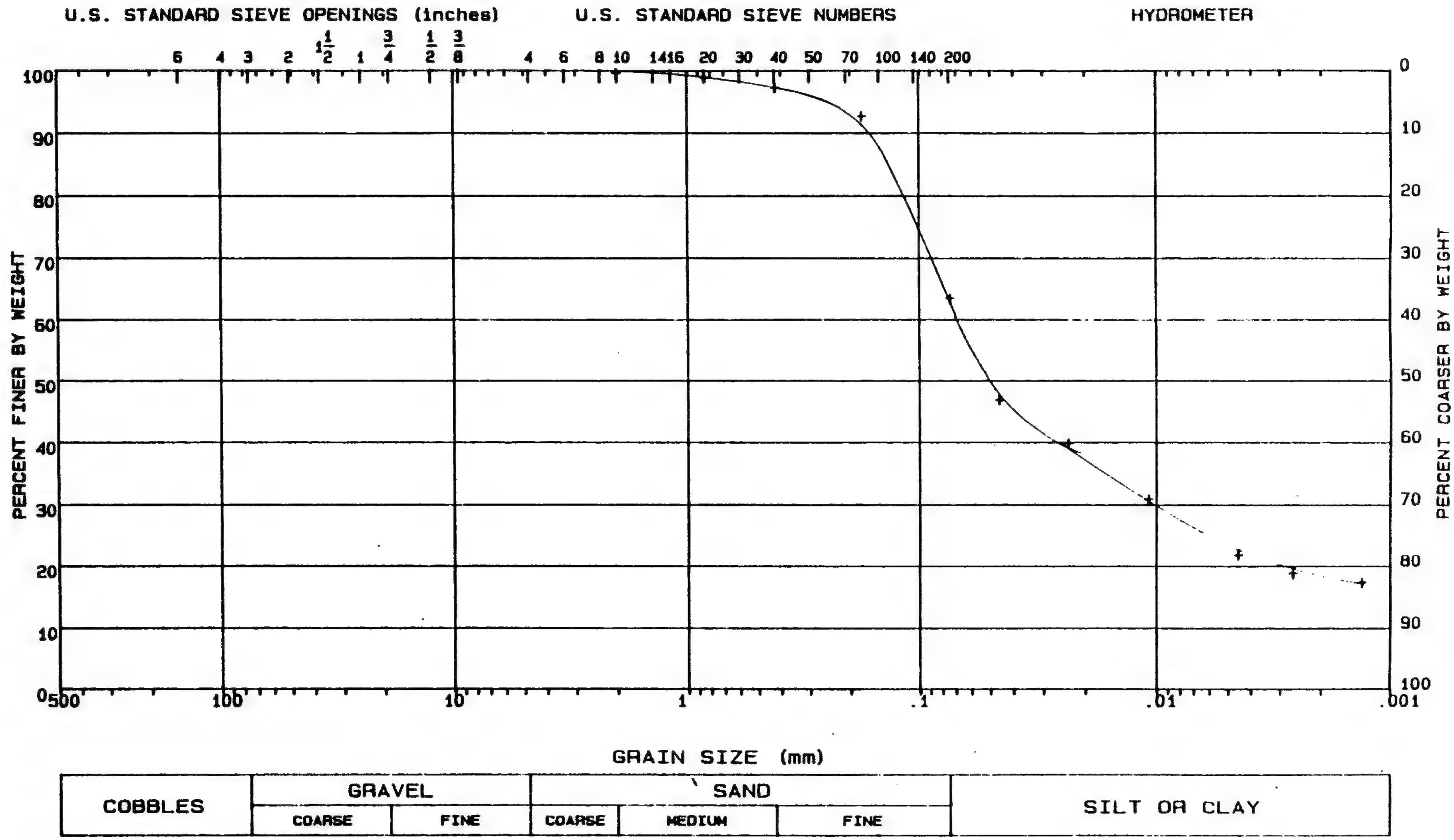
Project	: MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number	: 89-130 MU
Sample Number	: S-2
Depth	: 10'-12'
Confining Pressure	: 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.144	0.103	1.161	0.713	0.933	0.062
30	0.29	0.338	0.168	1.407	0.496	0.916	0.146
45	0.49	0.414	0.222	1.532	0.537	0.881	0.179
60	0.63	0.451	0.249	1.601	0.553	0.863	0.195
90	1.00	0.504	0.269	1.690	0.534	0.856	0.218
120	1.34	0.557	0.307	1.804	0.551	0.831	0.241
150	1.68	0.571	0.312	1.831	0.547	0.829	0.247
180	2.02	0.605	0.321	1.891	0.532	0.829	0.261
210	2.37	0.618	0.339	1.936	0.549	0.814	0.267
240	2.73	0.651	0.328	1.969	0.505	0.833	0.281
300	3.49	0.657	0.350	2.011	0.533	0.813	0.284
360	4.24	0.664	0.323	1.980	0.487	0.841	0.286
420	5.00	0.707	0.321	2.042	0.455	0.854	0.305
480	5.78	0.712	0.350	2.096	0.492	0.826	0.307
5[illegible]	6.56	0.735	0.330	2.098	0.450	0.852	0.317
6[illegible]	7.31	0.740	0.364	2.164	0.493	0.819	0.319
720	8.78	0.767	0.307	2.107	0.400	0.883	0.331
840	10.24	0.776	0.354	2.200	0.456	0.838	0.335
960	11.70	0.800	0.350	2.232	0.438	0.848	0.345
1080	13.33	0.786	0.294	2.114	0.375	0.901	0.339
1200	14.92	0.772	0.296	2.097	0.384	0.895	0.333
1206	15.00	0.771	0.297	2.096	0.386	0.894	0.333

Table 3 - Triaxial $\bar{R}$ Test Results

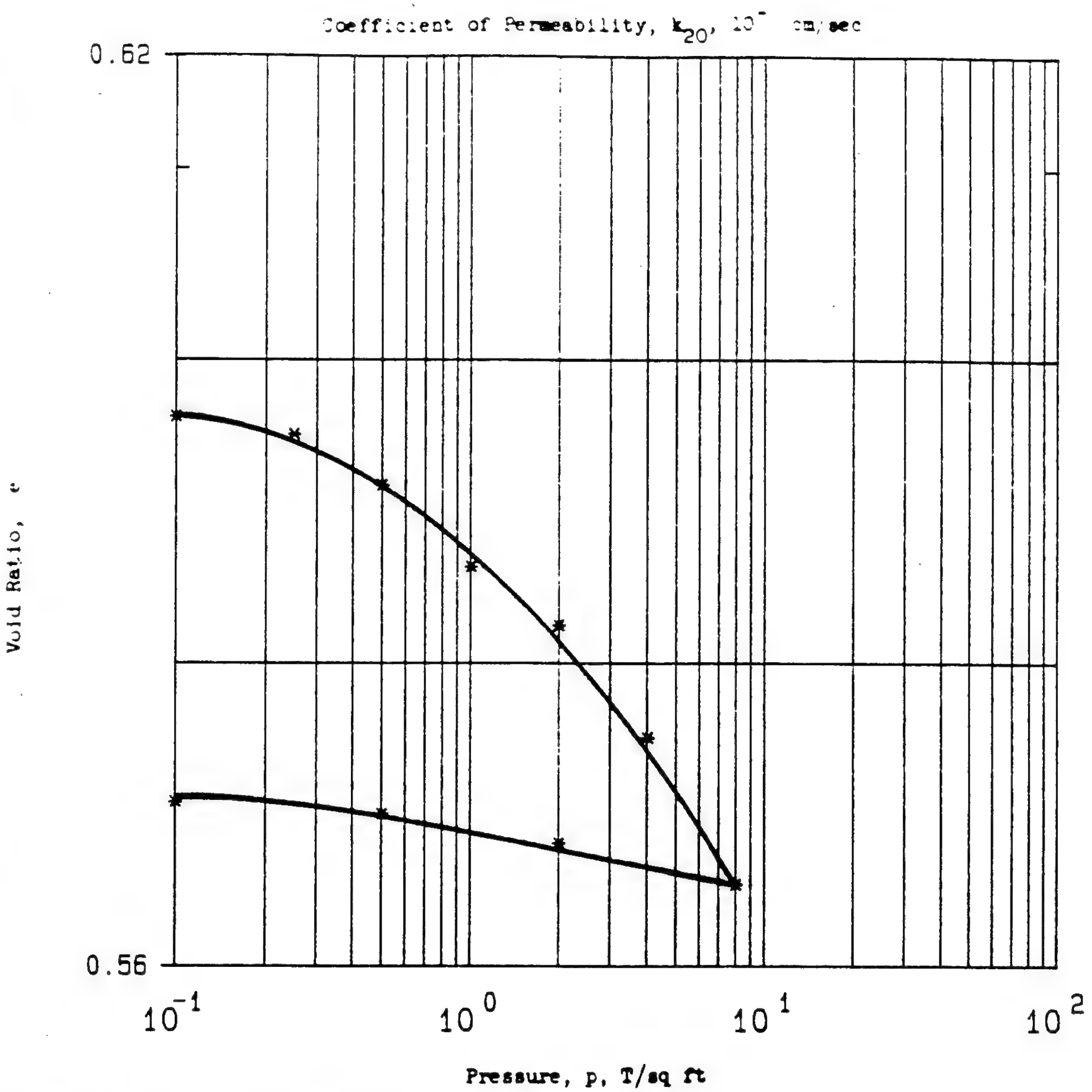
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-130 MU
Sample Number : S-2
Depth : 10'-12'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.13	0.712	0.297	1.418	0.417	1.879	0.307
30	0.30	1.084	0.601	1.775	0.555	1.667	0.468
45	0.49	1.205	0.756	1.969	0.628	1.542	0.520
60	0.64	1.290	0.882	2.154	0.684	1.437	0.557
90	1.01	1.353	1.020	2.381	0.755	1.315	0.584
120	1.36	1.433	1.081	2.559	0.755	1.274	0.618
150	1.71	1.459	1.157	2.731	0.794	1.204	0.630
180	2.05	1.486	1.188	2.830	0.800	1.180	0.641
210	2.40	1.512	1.194	2.877	0.791	1.180	0.652
240	2.77	1.537	1.208	2.942	0.787	1.173	0.663
300	3.53	1.569	1.230	3.038	0.785	1.158	0.677
360	4.30	1.583	1.267	3.160	0.801	1.125	0.683
420	5.07	1.613	1.288	3.264	0.799	1.111	0.696
480	5.86	1.625	1.281	3.261	0.789	1.121	0.701
[illegible]	6.65	1.636	1.292	3.312	0.790	1.113	0.706
600	7.41	1.648	1.297	3.344	0.787	1.111	0.711
720	8.90	1.671	1.277	3.311	0.765	1.137	0.721
840	10.38	1.676	1.300	3.395	0.776	1.115	0.724
960	11.86	1.696	1.267	3.315	0.748	1.153	0.732
1080	13.52	1.693	1.285	3.366	0.759	1.134	0.730
1190	15.00	1.689	1.270	3.315	0.753	1.148	0.729
1190	15.00	1.689	1.270	3.315	0.753	1.148	0.729



LL = 41	PL = 14	PI = 27	Gs = 2.65	NAT w = %	PROJECT	MINNESOTA RIVER; IA-90-0 -ED-GH
CLASSIFICATION	Sandy clay, CL				BORING NO.	89-130 MU
					SAMPLE NO.	S-2
					DEPTH/ELEV	10'-12'
GRADATION CURVE					MRD LAB NO.	90/135

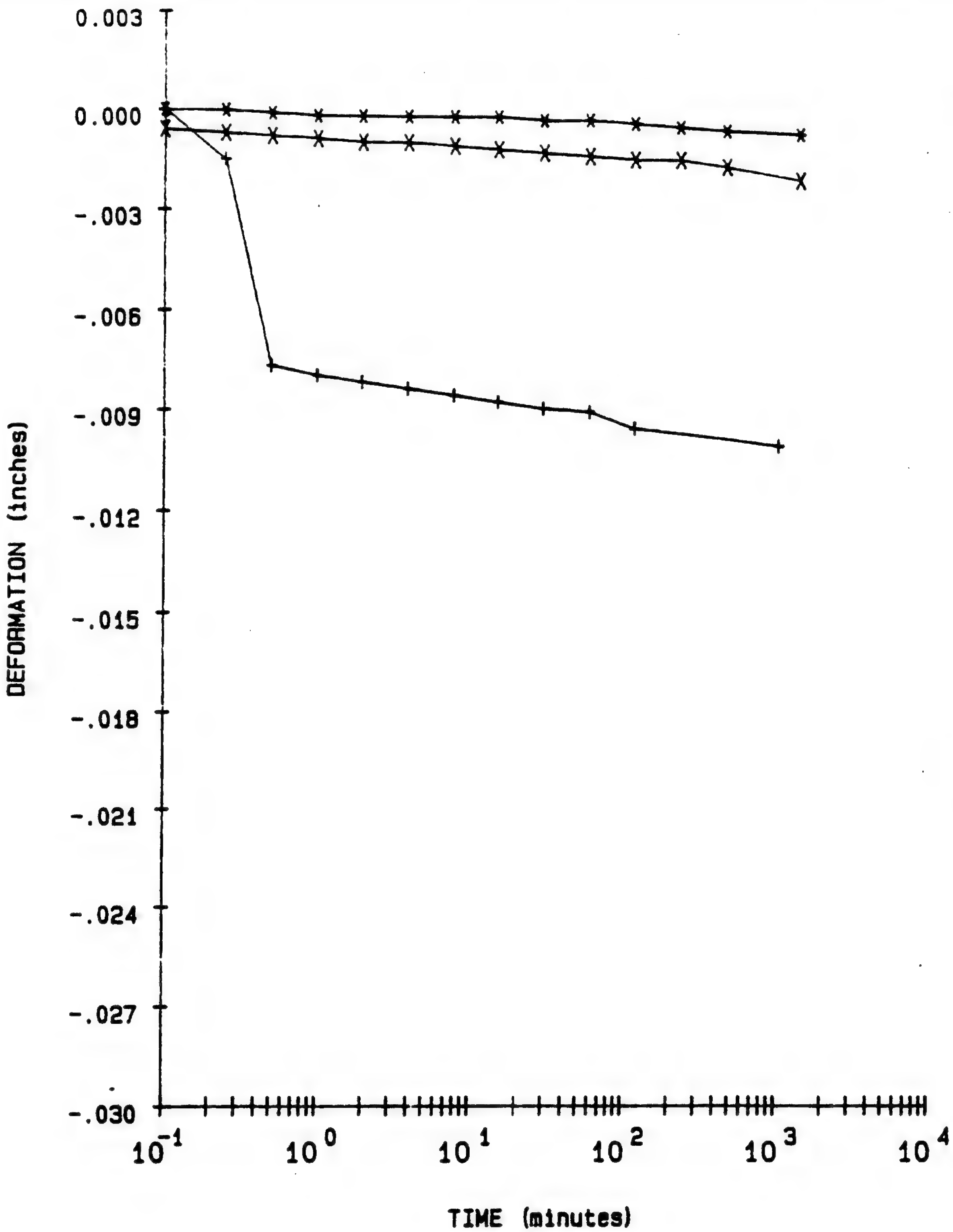
FIGURE 8



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.3 in.	Ht .997 in.	Water Content, w_o	21.3 %	w_f	21.9 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	0.61	e_f	0.57
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	95 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	105.3 lb/ft^3		
Classification Silt, ML-CL		k_{20} at e_o = × 10^{-} cm/sec			
LL 24	G_s 2.72	Project	MINNESOTA RIVER; IA-90-04-ED-GH		
PL 19	D_{10}				
Remarks Medium gray. Torvane=0.7		Area	MRD LAB NO. 90/135		
TSF. Slightly calcareous.		Boring No. 89-130 MU		Sample No. S-3	
		Depth El 21'-22.8'		Date	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

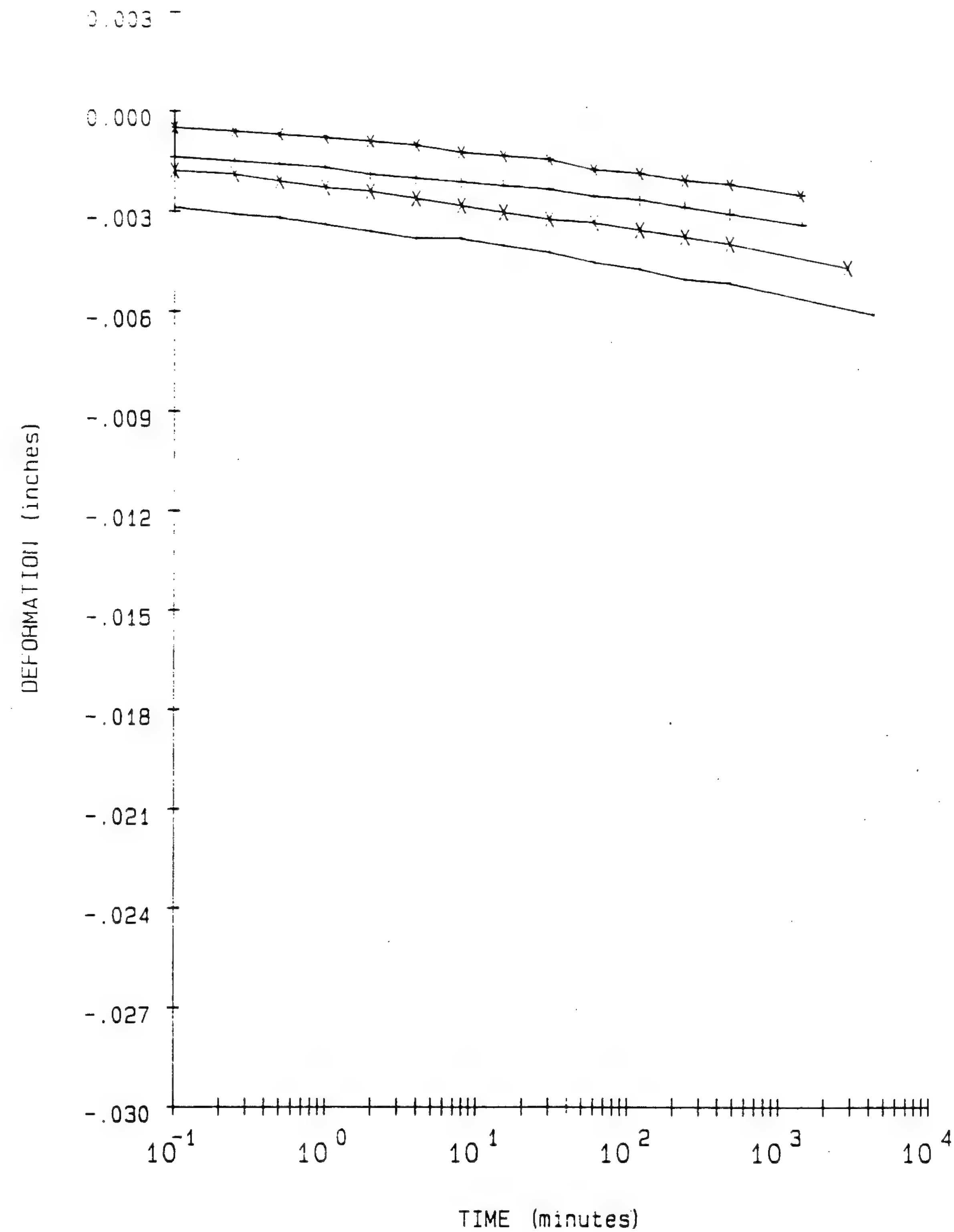
Figure 1



LEGEND	
+ = .1 TSF	
* = .25 TSF	
X = .5 TSF	

PROJECT	MINNESOTA RIVER: IA-90-04-ED-SH
BORING NO.	89-130 MU
SAMPLE NO.	S-3
DEPTH/ELEV	21'-22.8'
MRD LAB NO.	90/136

FIGURE 2

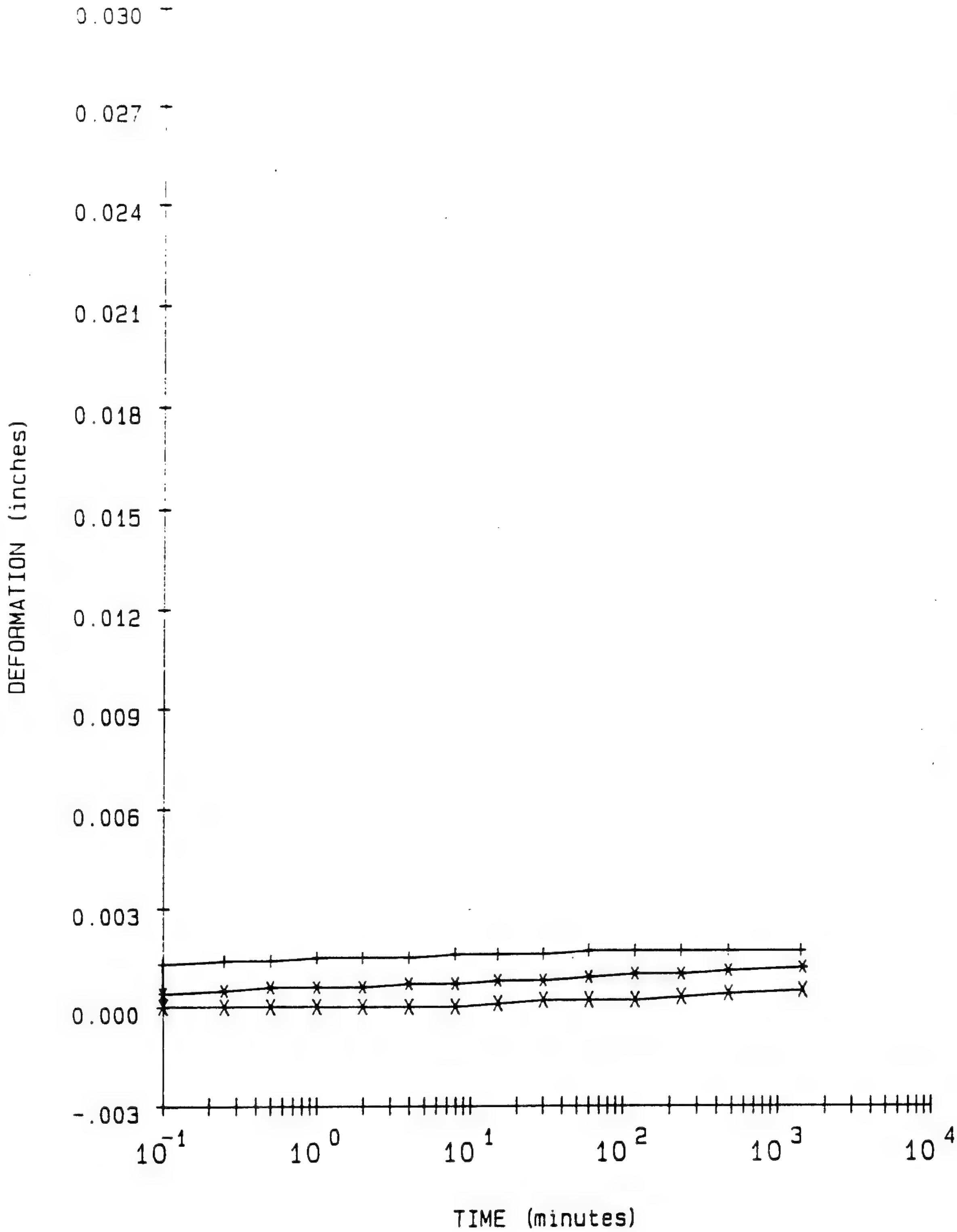


LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF
- = 8 TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-3
DEPTH/ELEV	21'-22.8'
MRD LAB NO.	90/135

FIGURE 3



LEGEND

+ = 2 TSF

* = .5 TSF

X = .1 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-3
DEPTH/ELEV	21'-22.8'
MRD LAB NO.	90/135

FIGURE 4

Consolidation Test Data

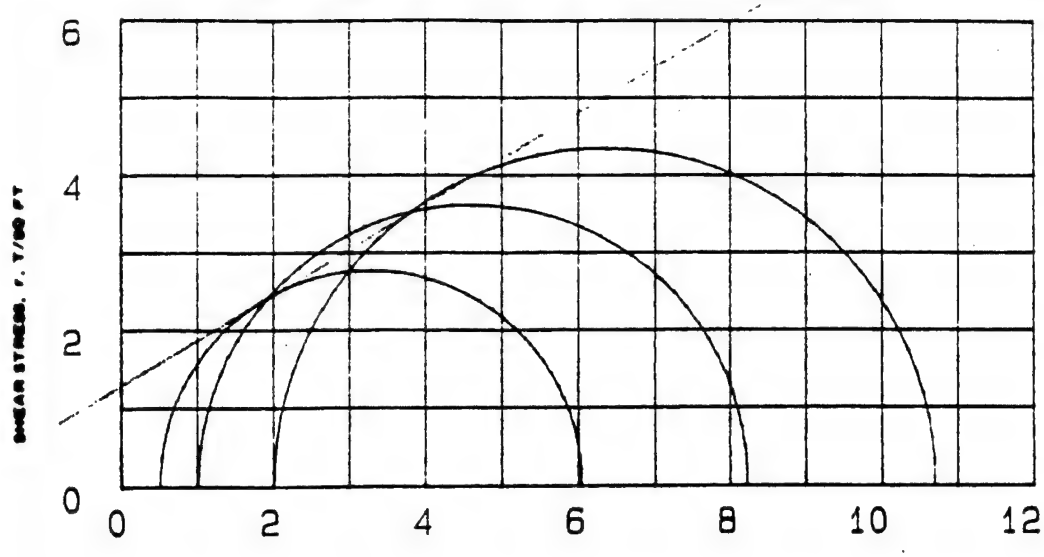
Project MINNESOTA RIVER; IA-90-04-ED-GH

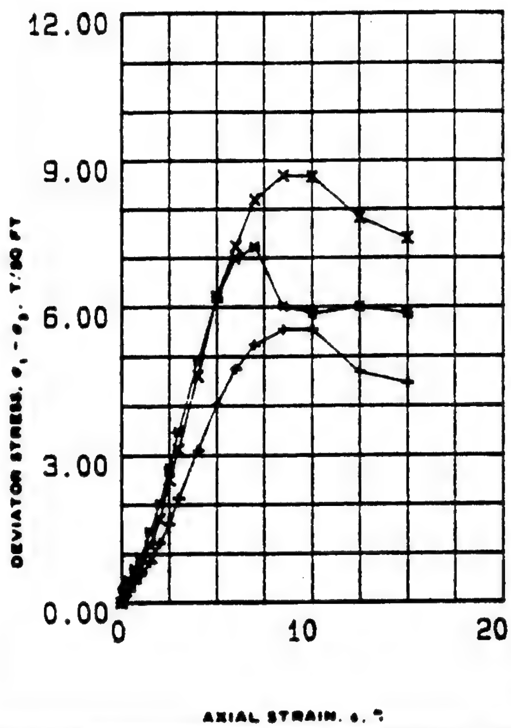
Boring No. 89-130 MU
Sample No. S-3
Depth/Elev 21'-22.8'
MRD Lab No. 90/135

Gs = 2.72
eo = 0.613
0.42eo = 0.257

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
21.3	398.7	105.3	0.613		94.7
21.9	398.7	106.3	0.596	0.10	100.0
21.9	398.7	106.4	0.595	0.25	100.0
21.9	398.7	106.6	0.592	0.50	100.0
21.9	398.7	107.0	0.586	1.00	100.0
21.9	398.7	107.3	0.582	2.00	100.0
21.9	398.7	107.8	0.575	4.00	100.0
1.9	398.7	108.4	0.565	8.00	100.0
1.9	398.7	108.2	0.568	2.00	100.0
21.9	398.7	108.1	0.570	0.50	100.0
21.9	398.7	108.0	0.571	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.596
2	0.580
3	0.564
4	0.548
5	0.532





			1 (+)	2 (*)	3 (X)
SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	19.5	18.4	19.0
	DRY DENSITY LB/CU FT	γ_{d_o}	110.2	111.5	111.7
	SATURATION, %	S_o	98.0	96.0	99.0
	VOID RATIO	e_o	0.54	0.52	0.52
BEFORE SHEAR	WATER CONTENT, %	w_c	19.3	18.3	19.0
	DRY DENSITY LB/CU FT	γ_{d_c}	110.2	111.5	111.7
	SATURATION, %	S_c	97.0	95.0	99.0
	VOID RATIO	e_c	0.54	0.52	0.52
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	5.54	7.23	8.69
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	21.0	18.5	22.3
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	4.44	5.85	7.39
INITIAL DIAMETER, IN.		D_o	1.43	1.43	1.42
INITIAL HEIGHT, IN.		H_o	2.95	2.95	2.99

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Silt, ML-CL

LL 24	PL 19	PI 5	G_s 2.72	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Medium gray. Torvane=0.7 TSF, slightly calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

BORING NO 89-130 MU SAMPLE NO. S-3

DEPTH ELEV 21'-22.8'

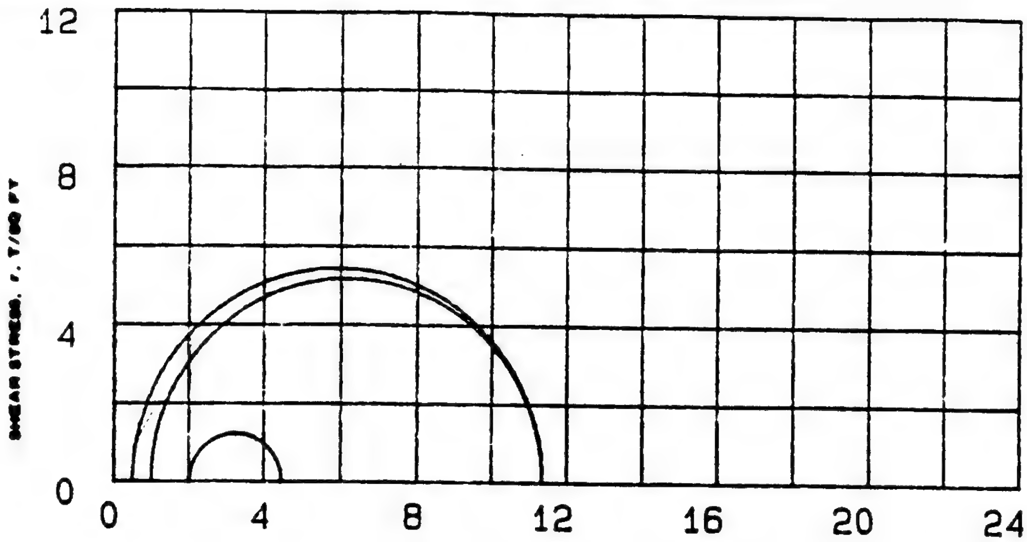
LABORATORY 90/135 DATE

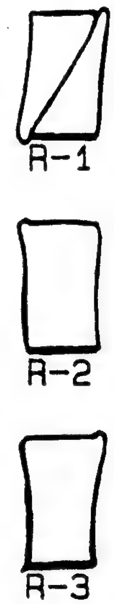
TRIAXIAL COMPRESSION TEST REPORT

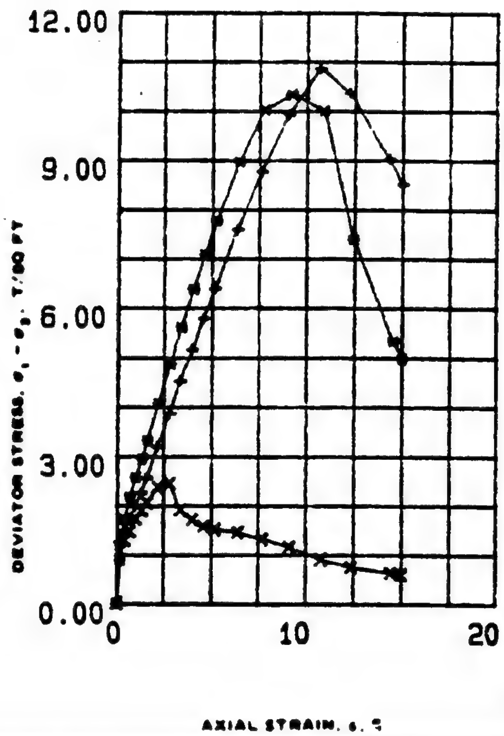
ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 5

Figure C-518







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	24.4	24.8	24.7	
	DRY DENSITY LB/CU FT	γ_{d_o}	101.7	103.5	103.2	
	SATURATION, %	S_o	99	100	100	
	VOID RATIO	e_o	.67	.64	.65	
BEFORE SHEAR	WATER CONTENT, %	w_c	24.5	24.4	26	
	DRY DENSITY LB/CU FT	γ_{d_c}	102	102.8	102.9	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.66	.65	.65	
	FINAL BACK PRESSURE, T/SQ FT	u_o	3.383	3.383	3.383	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	10.862	10.339	2.451	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	600	540	180	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	8.514	4.983	0.592	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.4	
INITIAL HEIGHT, IN.		H_o	3	2.94	2.96	

CONTROLLED- TEST

DESCRIPTION OF SPECIMENS Silt, ML-CL B-Value 1.0 1.0 1.0

LL 24	PL 19	PI 5	GS

TYPE OF SPECIMEN UNDISTURBED TYPE OF TEST R-BAR

REMARKS: Medium gray. Torvane=0.7 TSF. Slightly calcareous. Specimen #3 suffered a pinbole membrane failure and lost all strength. Insufficient material for rerun.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

BORING NO. 89-130 MU SAMPLE NO. S-3

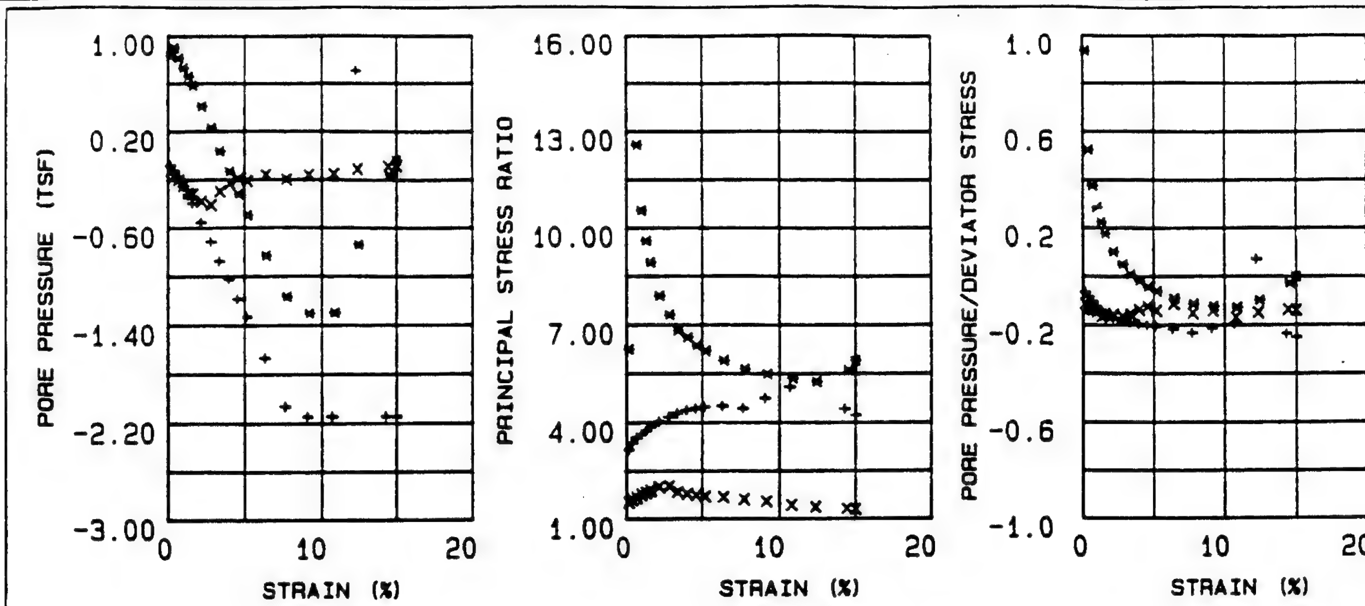
DEPTH ELEV 21'-22.8'

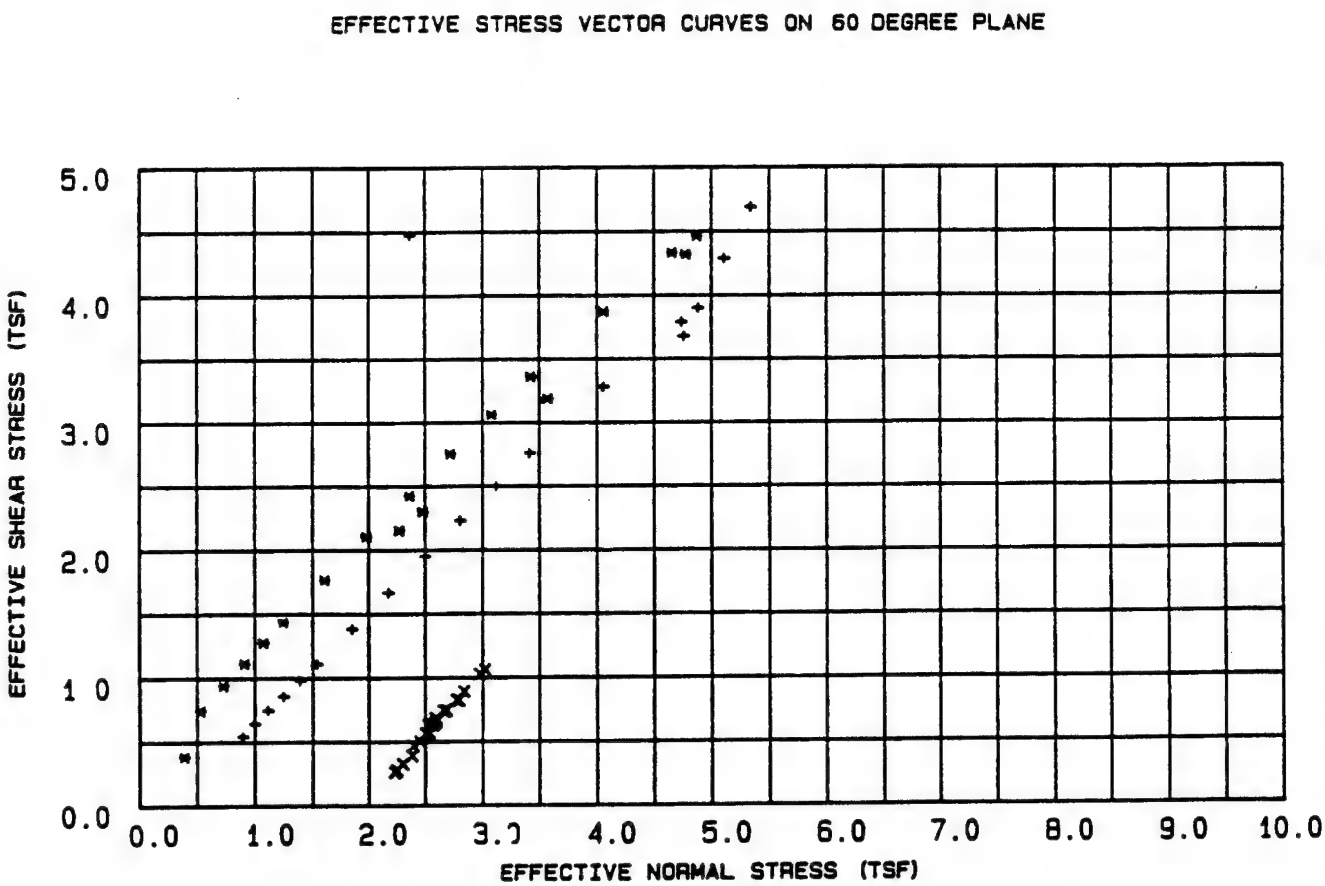
LABORATORY 90/135 DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)*
REV JUNE 1970

Figure 6





LEGEND

+ = .5 TSF

* = 1 TSF

X = 2 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-3
DEPTH/ELEV	21'-22.8'
MRD LAB NO.	90/135

FIGURE 7

R

Table 1 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-130 MU
Sample Number : S-3
Depth : 21'-22.8'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.17	1.254	-0.083	3.151	-0.066	0.893	0.541
30	0.40	1.484	-0.129	3.361	-0.086	0.996	0.641
45	0.69	1.730	-0.183	3.531	-0.106	1.111	0.747
60	1.00	1.982	-0.255	3.625	-0.128	1.246	0.855
90	1.31	2.267	-0.327	3.743	-0.144	1.388	0.978
120	1.59	2.568	-0.401	3.850	-0.156	1.537	1.109
150	2.16	3.200	-0.560	4.020	-0.174	1.852	1.381
180	2.80	3.863	-0.719	4.168	-0.186	2.175	1.667
210	3.34	4.523	-0.879	4.280	-0.194	2.499	1.952
240	3.96	5.162	-1.029	4.375	-0.199	2.807	2.228
300	4.53	5.787	-1.189	4.426	-0.205	3.122	2.498
360	5.13	6.394	-1.336	4.482	-0.208	3.419	2.760
420	6.31	7.601	-1.673	4.498	-0.220	4.055	3.281
[illegible]	7.64	8.776	-2.067	4.419	-0.235	4.740	3.788
540	9.06	9.934	-2.149	4.750	-0.216	5.108	4.288
600	10.68	10.862	-2.149	5.100	-0.197	5.338	4.688
720	12.22	10.359	0.706	%-49.294	0.069	2.359	4.471
840	14.29	9.027	-2.149	4.408	-0.238	4.884	3.896
895	15.00	8.514	-2.149	4.214	-0.253	4.757	3.675

Table 2 - Triaxial $\overline{R}$ Test Results

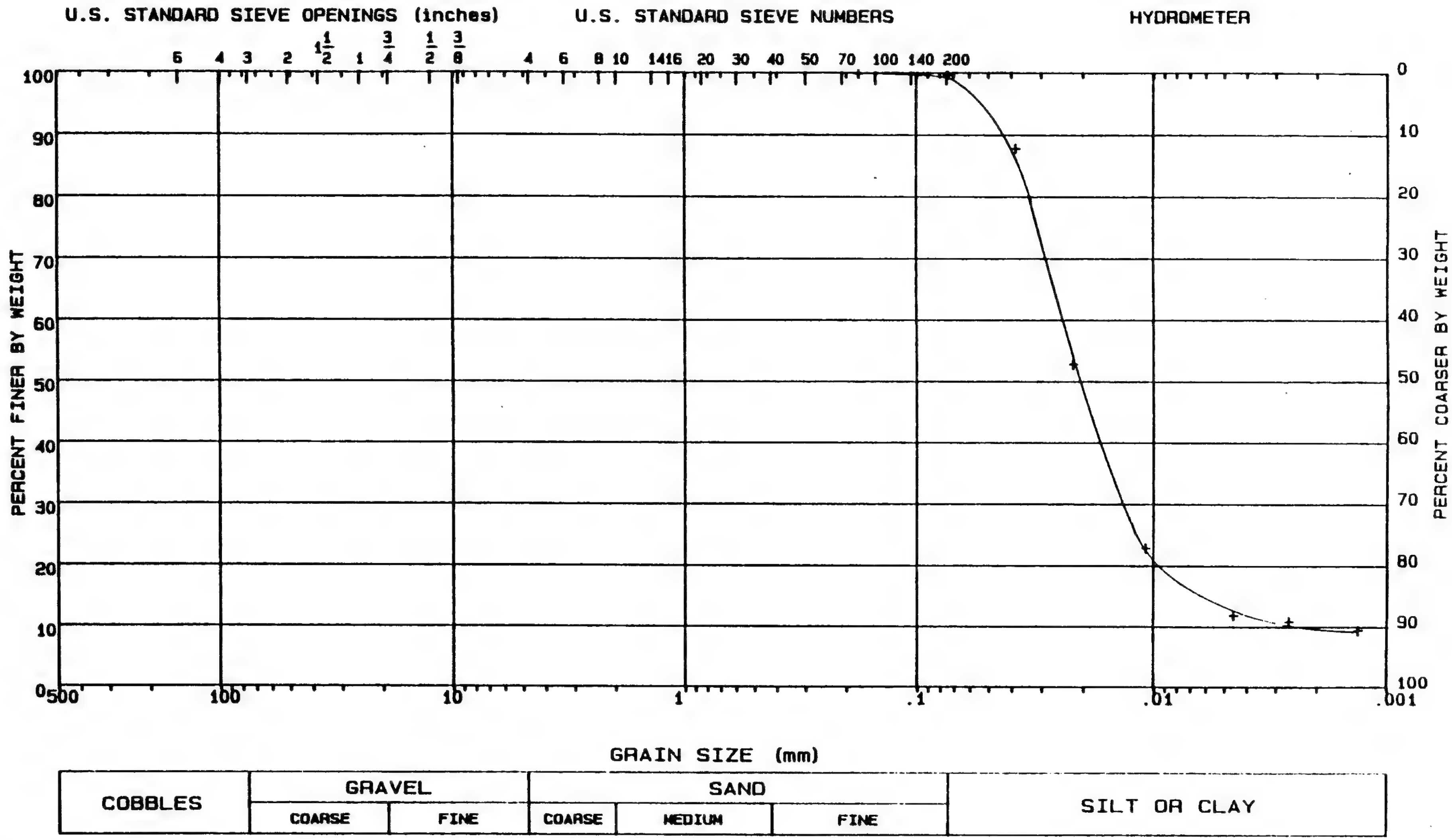
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-130 MU
Sample Number : S-3
Depth : 21'-22.8'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.17	0.889	0.831	6.250	0.935	0.389	0.384
30	0.41	1.723	0.901	18.456	0.523	0.526	0.744
45	0.70	2.180	0.812	12.571	0.373	0.728	0.941
60	1.01	2.578	0.729	10.522	0.283	0.909	1.113
90	1.33	2.955	0.656	9.582	0.222	1.075	1.275
120	1.62	3.330	0.579	8.914	0.174	1.245	1.437
150	2.20	4.092	0.406	7.886	0.100	1.607	1.766
180	2.85	4.876	0.225	7.292	0.047	1.982	2.105
210	3.40	5.621	0.032	6.808	0.006	2.360	2.426
240	4.03	6.386	-0.140	6.604	-0.021	2.721	2.756
300	4.61	7.092	-0.326	6.347	-0.046	3.082	3.061
360	5.22	7.786	-0.501	6.186	-0.064	3.429	3.361
420	6.42	8.971	-0.835	5.889	-0.093	4.056	3.872
480	7.78	10.036	-1.170	5.624	-0.116	4.655	4.332
5[illegible]	9.22	10.339	-1.311	5.473	-0.126	4.871	4.462
6[illegible]	10.87	10.001	-1.301	5.346	-0.130	4.777	4.317
720	12.44	7.382	-0.741	5.240	-0.100	3.569	3.186
840	14.54	5.326	-0.159	5.596	-0.029	2.478	2.299
875	15.00	4.983	-0.037	5.888	-0.002	2.271	2.151

Table 3 - Triaxial $\overline{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-130 MU
Sample Number : S-3
Depth : 21'-22.8'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.17	1.085	-0.125	1.511	-0.114	2.394	0.468
30	0.41	1.300	-0.176	1.598	-0.135	2.498	0.561
45	0.70	1.463	-0.206	1.663	-0.140	2.568	0.631
60	1.01	1.725	-0.256	1.764	-0.148	2.683	0.744
90	1.32	1.901	-0.319	1.820	-0.167	2.790	0.820
120	1.61	2.059	-0.326	1.885	-0.158	2.836	0.889
150	2.18	2.374	-0.384	1.996	-0.161	2.972	1.025
180	2.83	2.451	-0.415	2.015	-0.169	3.022	1.058
210	3.38	1.904	-0.301	1.827	-0.158	2.772	0.822
240	4.00	1.704	-0.236	1.762	-0.138	2.658	0.736
300	4.58	1.574	-0.198	1.716	-0.125	2.588	0.679
360	5.18	1.508	-0.216	1.681	-0.143	2.589	0.651
420	6.38	1.444	-0.166	1.666	-0.115	2.523	0.623
480	7.72	1.313	-0.204	1.596	-0.155	2.529	0.567
[illegible]	9.16	1.152	-0.166	1.532	-0.144	2.451	0.497
[illegible]	10.79	0.899	-0.155	1.417	-0.171	2.378	0.388
720	12.35	0.745	-0.113	1.353	-0.151	2.298	0.322
840	14.43	0.630	-0.088	1.302	-0.139	2.244	0.272
883	15.00	0.592	-0.084	1.284	-0.141	2.230	0.256



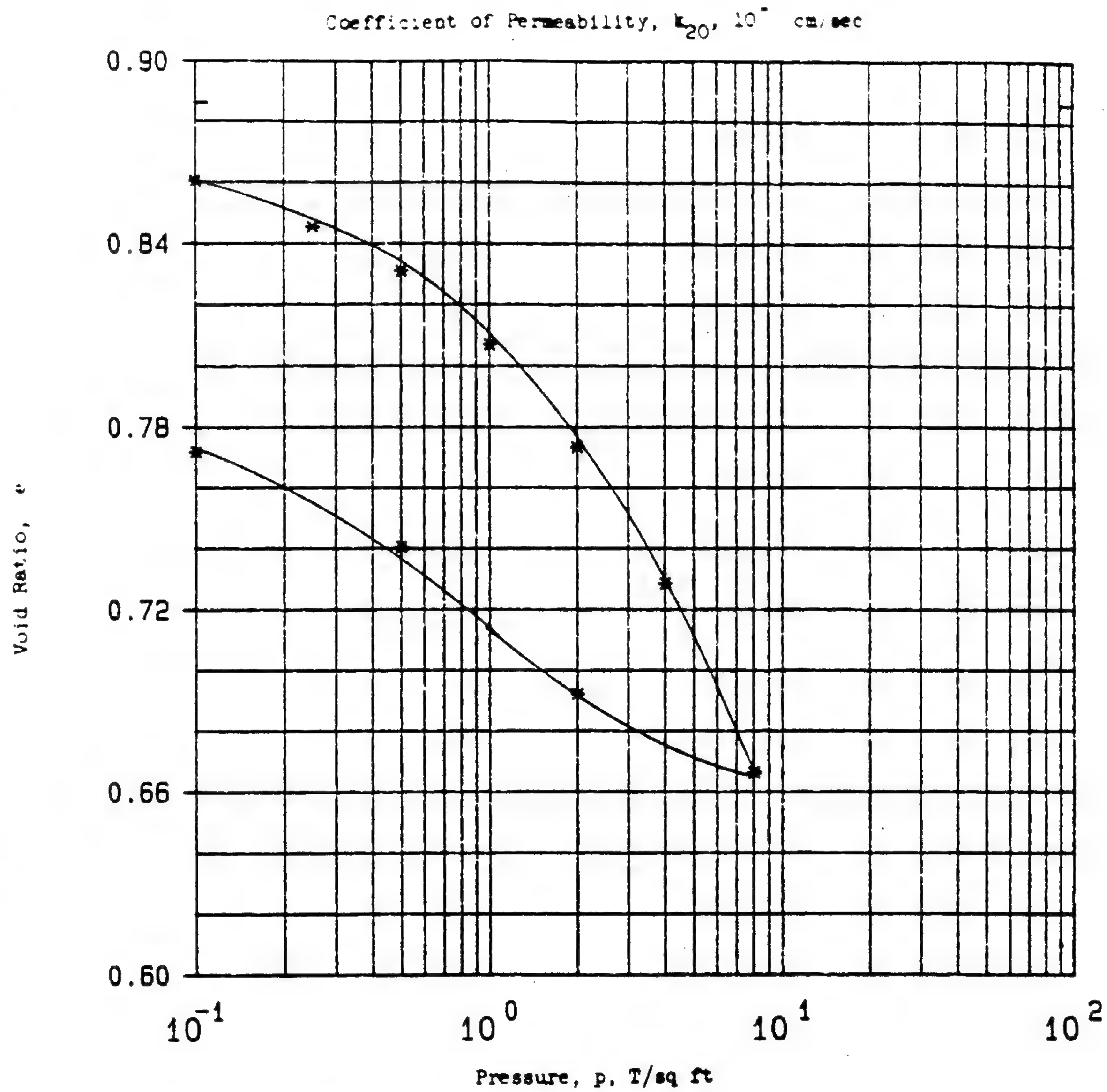
LL - 24	PL - 19	PI - 5	Gs - 2.72	NAT w - %

CLASSIFICATION Silt, ML-CL

GRADATION CURVE

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-3
DEPTH/ELEV	21'-22.8'
MRD LAB NO.	90/135

FIGURE 8



Type of Specimen	UNDISTURBED		
Diam 4.3 in.	Ht 1 in.		
Overburden Pressure, p_o	T/sq ft		
Preconsol. Pressure, p_c	T/sq ft		
Compression Index, C_c			
Classification	Fat clay, CH		
LL	52	G_s	2.73
PL	19	D_{10}	

	Before Test		After Test
Water Content, w_o	30.5 %	w_f	30.0 %
Void Ratio, e_o	0.89	e_f	0.77
Saturation, S_o	94 %	S_f	100 %
Dry Density, γ_d	90.3 lb/ft^3		
k_{20} at e_o =	× 10^{-} cm/sec		

Remarks Medium gray. Torvane=1.3 TSF. Calcareous.

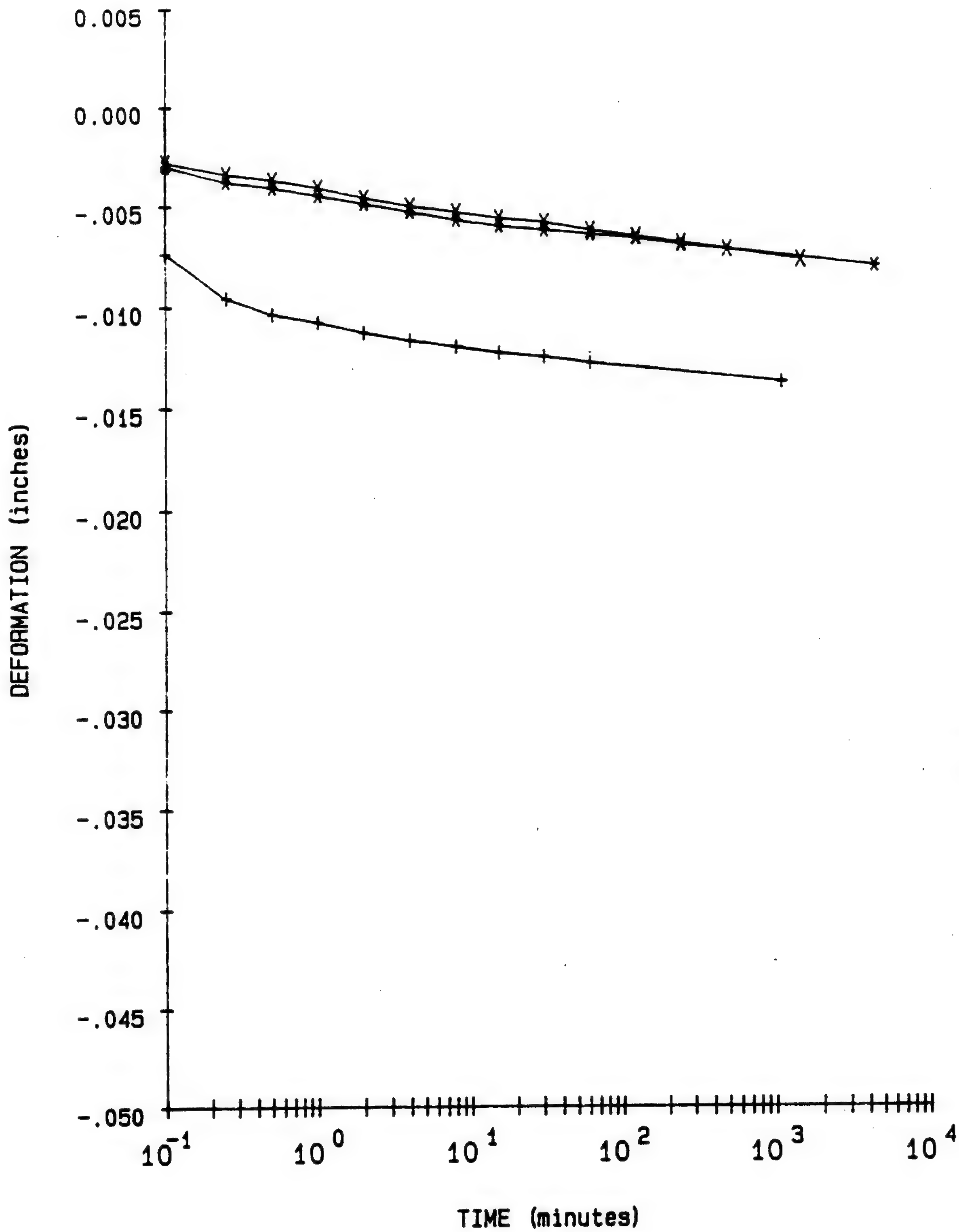
Project	MINNESOTA RIVER; IA-90-04-ED-GH		
Area	MRD LAB NO. 90/135		
Boring No.	89-130 MU	Sample No.	S-4
Depth El	34'-36'	Date	–

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 1

Figure C-525

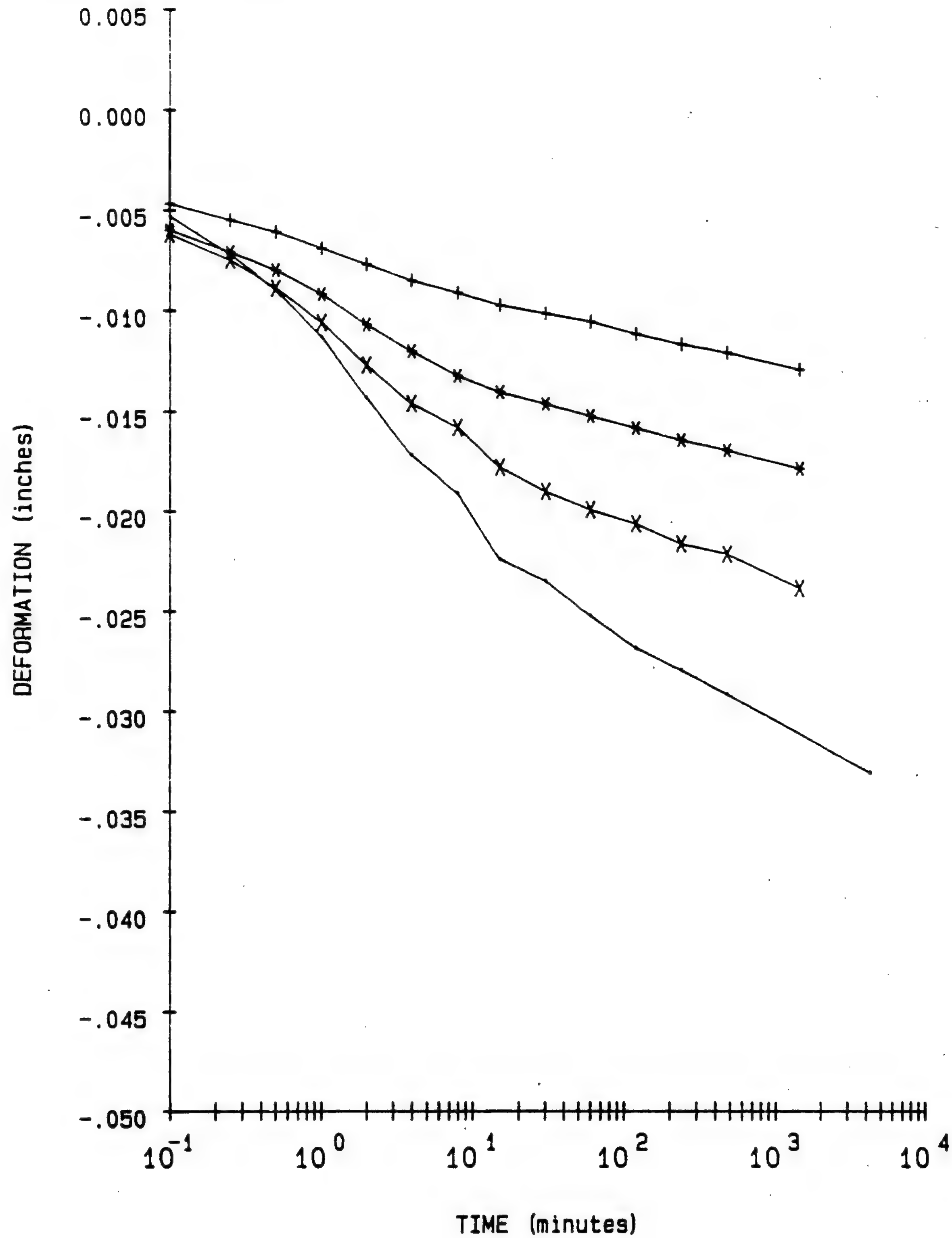


LEGEND

+ = .1 TSF
* = .25 TSF
X = .5 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-4
DEPTH/ELEV	34'-36'
MRD LAB NO.	90/135

FIGURE 2

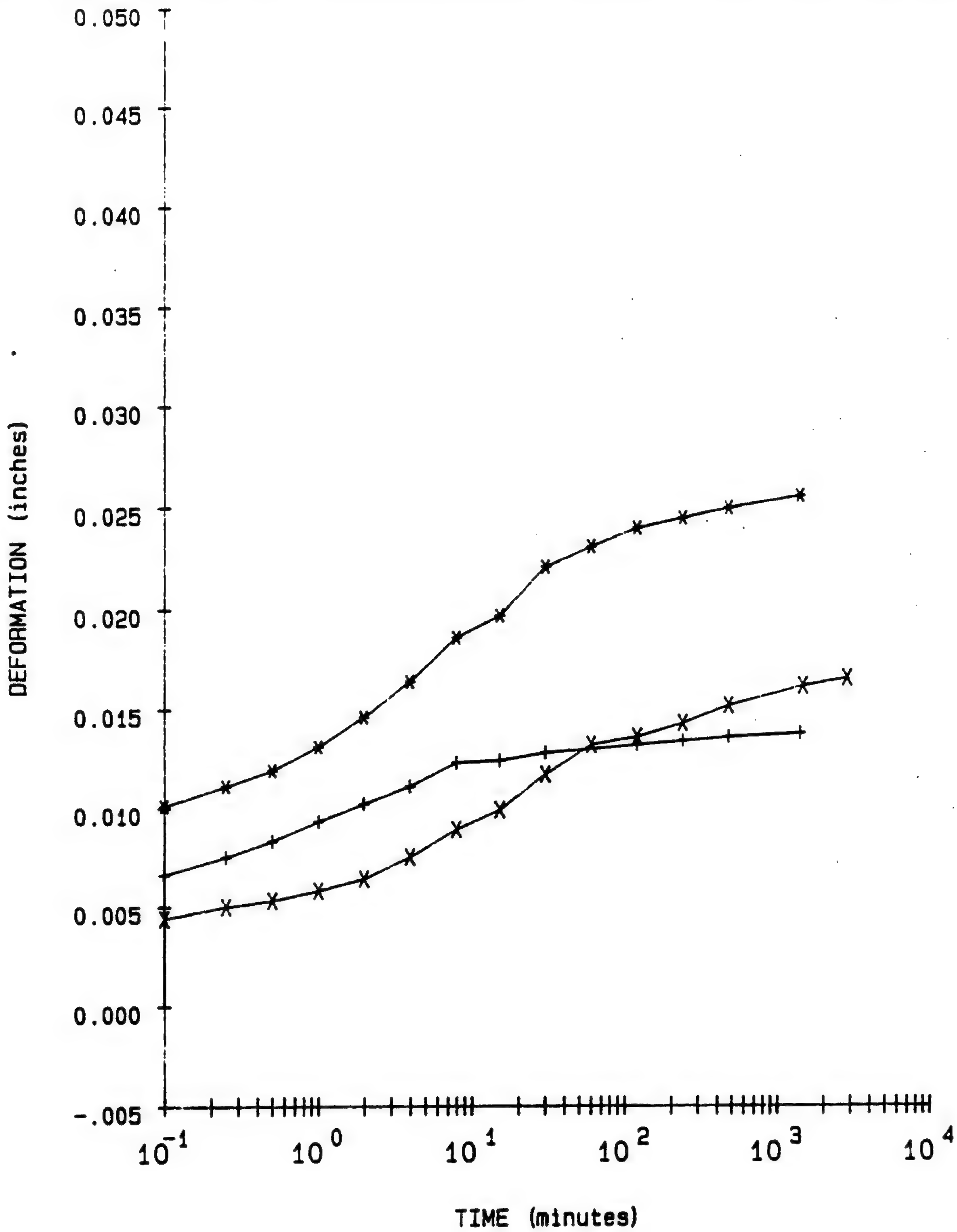


LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF
- = 8 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-4
DEPTH/ELEV	34'-38'
MRD LAB NO.	90/135

FIGURE 3



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-4
DEPTH/ELEV	34'-36'
MRD LAB NO.	90/135

FIGURE 4

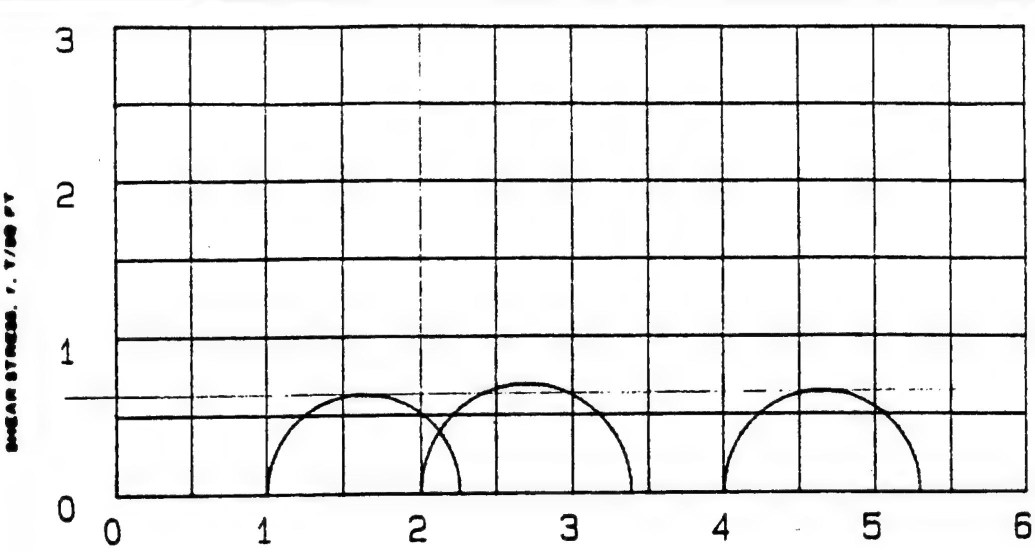
Consolidation Test Data

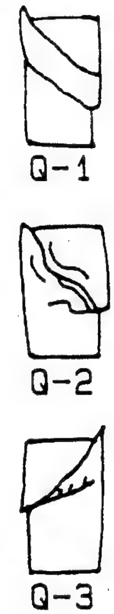
Project	MINNESOTA RIVER; IA-90-04-ED-GH
Boring No.	89-130 MU
Sample No.	S-4
Depth/Elev	34'-36'
MRD Lab No.	90/135

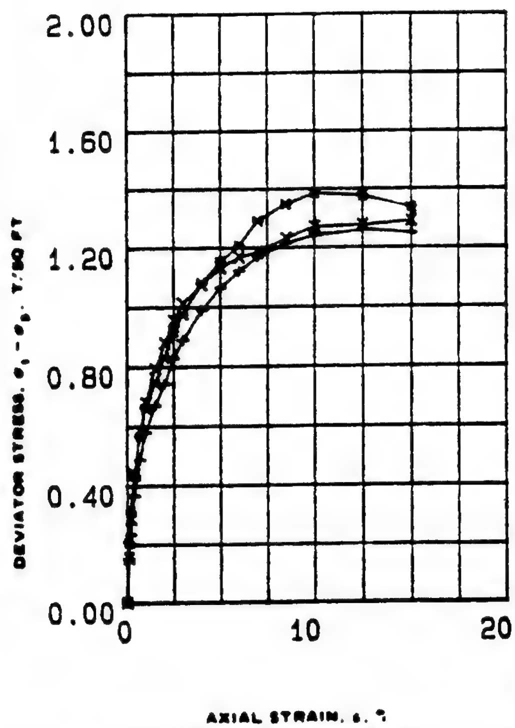
Gs = 2.73
eo = 0.886
0.42eo = 0.372

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
30.5	342.1	90.3	0.886		94.1
30.0	342.1	91.6	0.860	0.10	95.2
30.0	342.1	92.3	0.845	0.25	96.9
30.0	342.1	93.0	0.831	0.50	98.6
30.0	342.1	94.3	0.807	1.00	100.0
30.0	342.1	96.1	0.773	2.00	100.0
30.0	342.1	98.6	0.728	4.00	100.0
30.0	342.1	102.2	0.666	8.00	100.0
30.0	342.1	100.7	0.692	2.00	100.0
30.0	342.1	97.9	0.740	0.50	100.0
30.0	342.1	96.1	0.772	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.867
2	0.848
3	0.829
4	0.811
5	0.792
6	0.773
7	0.754
8	0.735
9	0.716
10	0.697
11	0.679
12	0.660
13	0.641
14	0.622







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	30.1	29.4	31.0	
	DRY DENSITY LB/CU FT	γ_{d_o}	93.4	93.4	91.9	
	SATURATION, %	S_o	100.0	97.0	99.0	
	VOID RATIO	e_o	0.83	0.83	0.85	
BEFORE SHEAR	WATER CONTENT, %	w_c	30.1	29.2	31.0	
	DRY DENSITY LB/CU FT	γ_{d_c}	93.4	93.4	91.9	
	SATURATION, %	S_c	100.0	97.0	99.0	
	VOID RATIO	e_c	0.83	0.83	0.85	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.0	2.0	4.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.26	1.39	1.29	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	27.0	21.3	32.3	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.25	1.34	1.29	
INITIAL DIAMETER, IN.		D_o	1.42	1.42	1.42	
INITIAL HEIGHT, IN.		H_o	2.96	2.95	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH

LL 52 | PL 19 | PI 33 | G_s 2.73

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST Q

REMARKS: Medium gray. Torvane=1.3TSF. Calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-GH

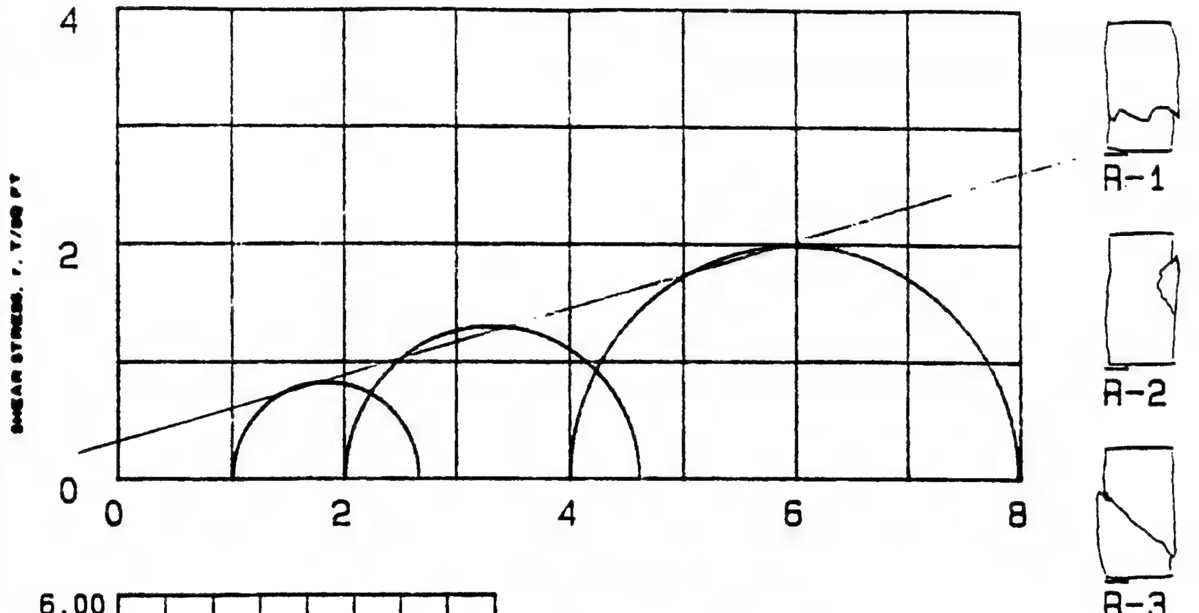
BORING NO 89-130 MU | SAMPLE NO. S-4

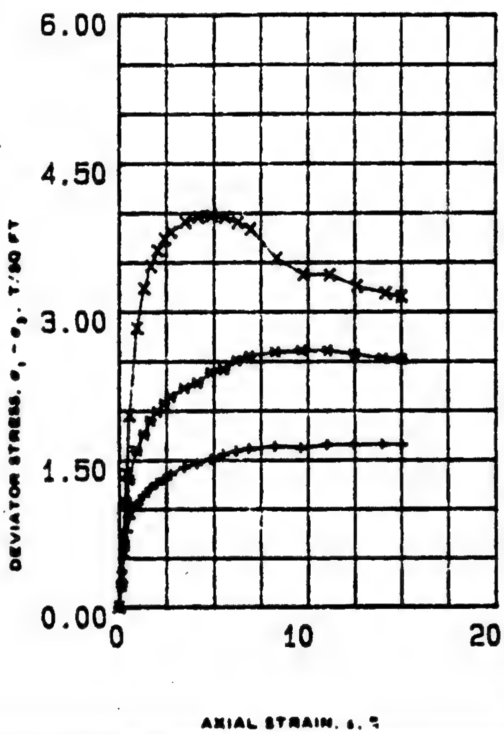
DEPTH ELEV 34'-36'

LABORATORY 90/135 | DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 5





			1 (+)	2 (*)	3 (X)	
SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT %	w_o	34.4	31.7	31.4	
	DRY DENSITY LB/CU FT	γ_{d_o}	89.5	91.6	90.2	
	SATURATION %	S_o	100	100	96	
	VOID RATIO	e_o	.9	.86	.89	
BEFORE SHEAR	WATER CONTENT, %	w_c	35.2	31.6	31.3	
	DRY DENSITY LB/CU FT	γ_{d_c}	91.6	94.5	96.2	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.86	.8	.77	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.823	4.823	4.823	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1	2	4	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.660	2.610	3.975	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1200	840	420	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.655	2.517	3.147	
INITIAL DIAMETER, IN		D_o	1.4	1.39	1.41	
INITIAL HEIGHT, IN.		H_o	3	2.99	3	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH B-Value 1.0 1.0 1.0

LL 52	PL 19	PI 33	Gs 2.73	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Medium gray. Torvane=1.3 TSF

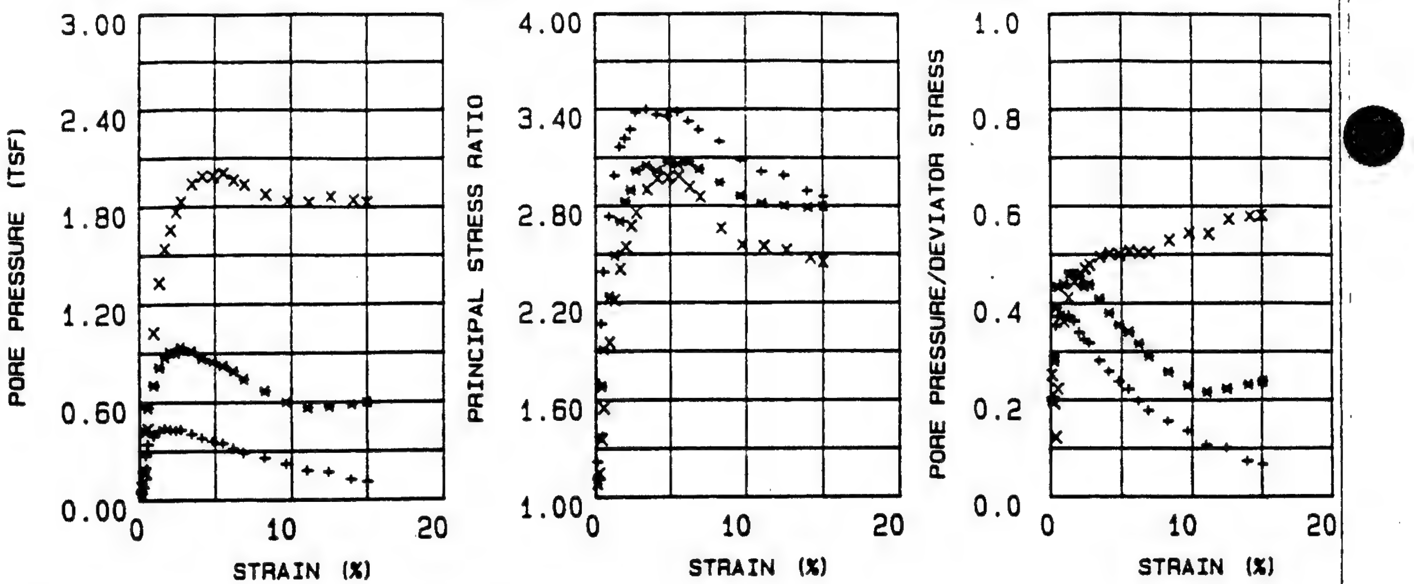
Calcareous.

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO 89-130 MU	SAMPLE NO. S-4
DEPTH ELEV 34'-36'	
LABORATORY 90/135	DATE

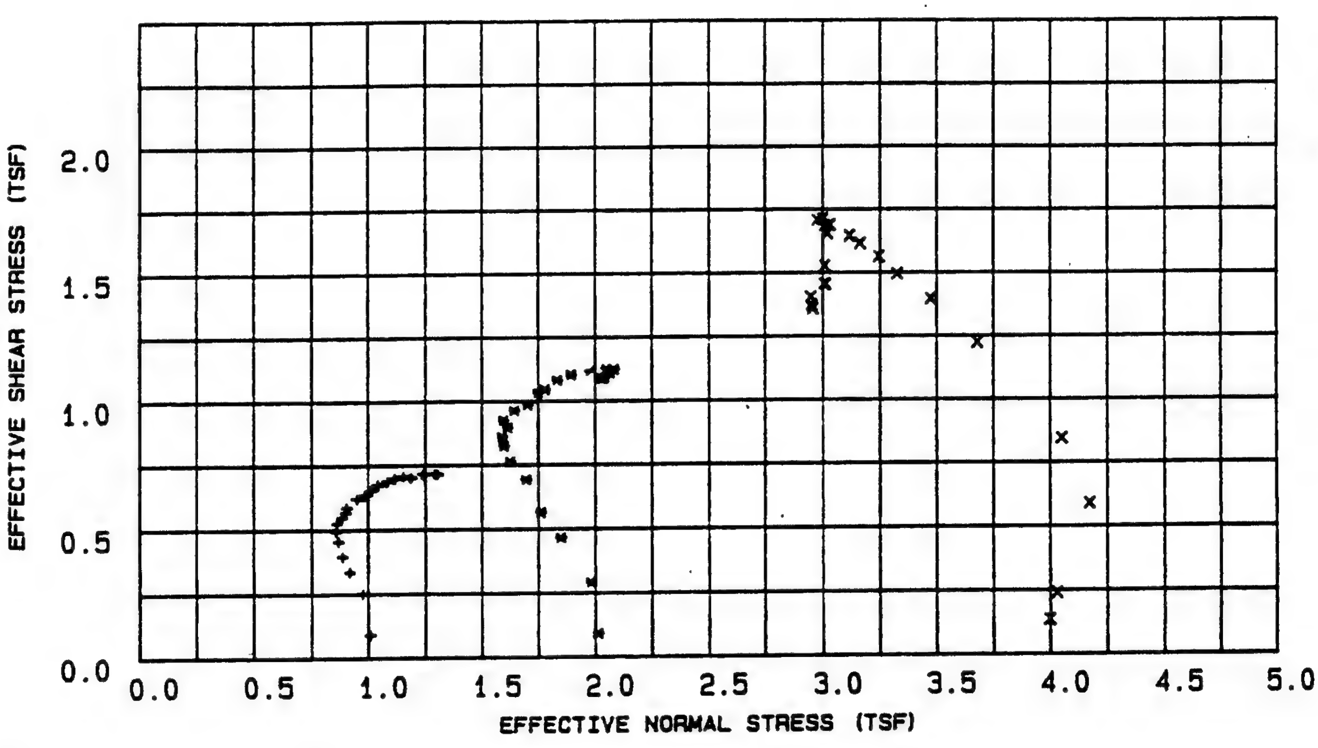
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 6



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = 1 TSF

✱ = 2 TSF

X = 4 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-4
DEPTH/ELEV	34'-36'
MRD LAB NO.	90/135

FIGURE 7

Figure C-532

R

Table 1 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-130 MU
Sample Number : S-4
Depth : 34'-36'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.206	0.042	1.215	0.204	1.009	0.089
30	0.26	0.580	0.169	1.698	0.291	0.975	0.250
45	0.41	0.775	0.274	2.067	0.354	0.918	0.334
60	0.55	0.915	0.341	2.388	0.373	0.886	0.395
90	0.94	1.050	0.393	2.730	0.374	0.867	0.453
120	1.29	1.141	0.426	2.985	0.374	0.856	0.492
150	1.65	1.212	0.440	3.165	0.363	0.860	0.523
180	2.01	1.266	0.429	3.216	0.339	0.885	0.547
210	2.37	1.311	0.424	3.274	0.324	0.901	0.566
240	2.71	1.356	0.430	3.377	0.317	0.906	0.585
300	3.43	1.434	0.402	3.398	0.281	0.953	0.619
360	4.10	1.469	0.378	3.364	0.258	0.986	0.634
420	4.80	1.512	0.358	3.355	0.237	1.016	0.653
[illegible]	5.49	1.562	0.345	3.384	0.221	1.042	0.674
[illegible]	6.17	1.595	0.313	3.322	0.197	1.082	0.688
600	6.86	1.618	0.286	3.268	0.177	1.115	0.698
720	8.23	1.639	0.254	3.196	0.155	1.152	0.707
840	9.62	1.625	0.218	3.078	0.135	1.184	0.701
960	11.01	1.658	0.175	3.010	0.106	1.236	0.716
1080	12.43	1.657	0.166	2.986	0.100	1.244	0.715
1200	13.94	1.660	0.121	2.888	0.073	1.290	0.717
1281	15.00	1.655	0.107	2.854	0.066	1.302	0.714

Table 2 - Triaxial $\overline{R}$ Test Results

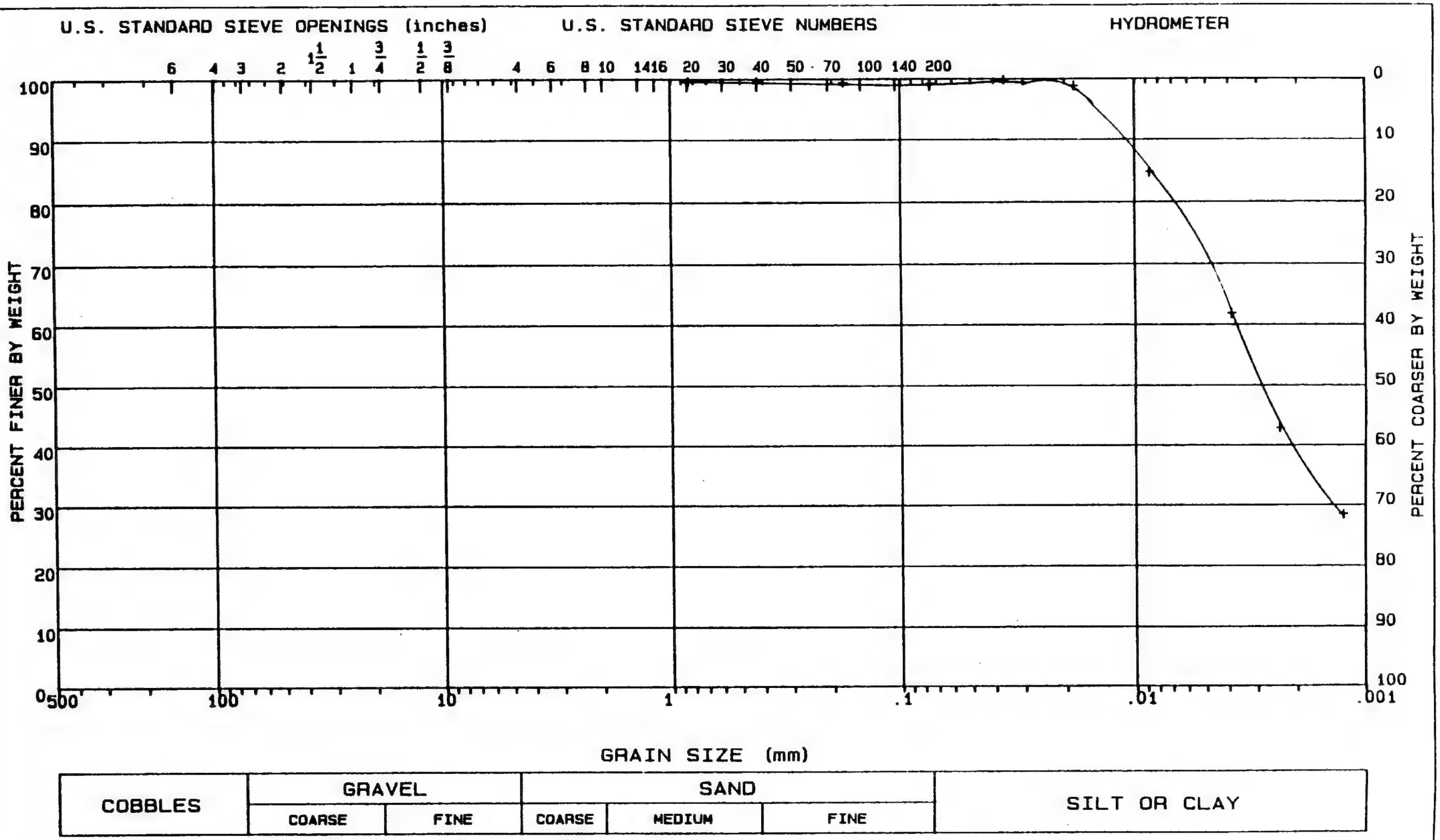
Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-130 MU
Sample Number : S-4
Depth : 34'-36'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.210	0.041	1.107	0.197	2.011	0.091
30	0.26	0.673	0.188	1.371	0.280	1.979	0.290
45	0.41	1.076	0.421	1.682	0.391	1.846	0.465
60	0.55	1.305	0.565	1.909	0.433	1.758	0.563
90	0.94	1.604	0.703	2.237	0.439	1.694	0.692
120	1.30	1.767	0.814	2.490	0.461	1.624	0.763
150	1.66	1.910	0.877	2.701	0.460	1.596	0.824
180	2.02	1.995	0.906	2.824	0.455	1.588	0.861
210	2.38	2.078	0.903	2.895	0.435	1.612	0.897
240	2.72	2.144	0.937	3.017	0.438	1.594	0.925
300	3.44	2.233	0.911	3.050	0.408	1.642	0.964
360	4.12	2.286	0.865	3.014	0.379	1.701	0.986
420	4.82	2.392	0.845	3.070	0.354	1.747	1.032
480	5.51	2.422	0.822	3.057	0.340	1.778	1.045
5	6.19	2.508	0.789	3.070	0.315	1.832	1.082
600	6.88	2.555	0.739	3.025	0.290	1.893	1.103
720	8.26	2.593	0.665	2.942	0.257	1.977	1.119
840	9.65	2.610	0.597	2.860	0.229	2.049	1.126
960	11.05	2.607	0.562	2.813	0.216	2.084	1.125
1080	12.47	2.568	0.571	2.797	0.223	2.065	1.109
1200	13.99	2.526	0.586	2.786	0.232	2.039	1.090
1277	15.00	2.517	0.597	2.794	0.238	2.026	1.087

Table 3 - Triaxial $\overline{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-130 MU
Sample Number : S-4
Depth : 34'-36'
Confining Pressure : 4 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.313	0.079	1.080	0.252	3.998	0.135
30	0.27	0.557	0.108	1.143	0.194	4.030	0.240
45	0.41	1.362	0.166	1.355	0.122	4.171	0.588
60	0.56	1.955	0.435	1.548	0.223	4.049	0.844
90	0.95	2.834	1.024	1.952	0.362	3.678	1.223
120	1.31	3.237	1.330	2.213	0.411	3.471	1.397
150	1.68	3.464	1.537	2.407	0.444	3.321	1.495
180	2.04	3.620	1.653	2.543	0.457	3.243	1.563
210	2.41	3.741	1.765	2.674	0.472	3.161	1.615
240	2.75	3.810	1.828	2.754	0.480	3.115	1.645
300	3.48	3.911	1.939	2.898	0.496	3.029	1.688
360	4.16	3.961	1.985	2.966	0.502	2.996	1.709
420	4.87	~~3.975~~	1.985	2.973	0.500	2.999	1.715
480	5.57	3.955	2.006	2.983	0.508	2.973	1.707
[illegible]	6.25	3.903	1.960	2.913	0.503	3.006	1.685
600	6.96	3.834	1.931	2.853	0.504	3.018	1.655
720	8.35	3.536	1.869	2.659	0.529	3.007	1.526
840	9.76	3.372	1.832	2.555	0.544	3.003	1.455
960	11.17	3.368	1.823	2.547	0.542	3.011	1.454
1080	12.61	3.252	1.861	2.520	0.573	2.944	1.404
1200	14.14	3.179	1.840	2.472	0.579	2.947	1.372
1265	15.00	3.147	1.826	2.448	0.581	2.952	1.358



LL - 52	PL - 19	PI - 33	Gs - 2.73	NAT w - %

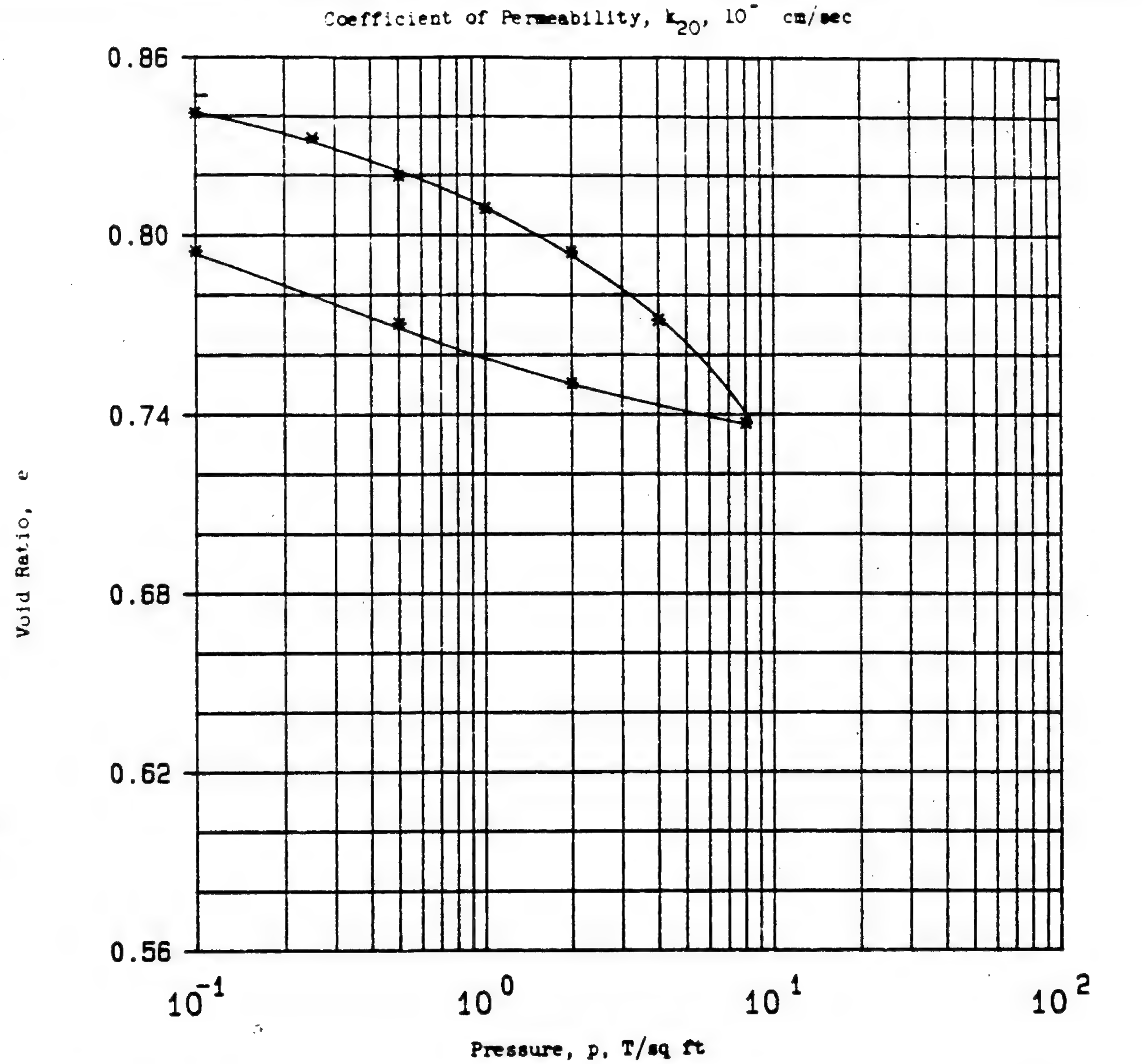
CLASSIFICATION Fat clay, CH

PROJECT	MINNESOTA PIVER; IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-4
DEPTH/ELEV	34'-36'
MRD LAB NO.	90/135

GRADATION CURVE

FIGURE 8

Figure C-536

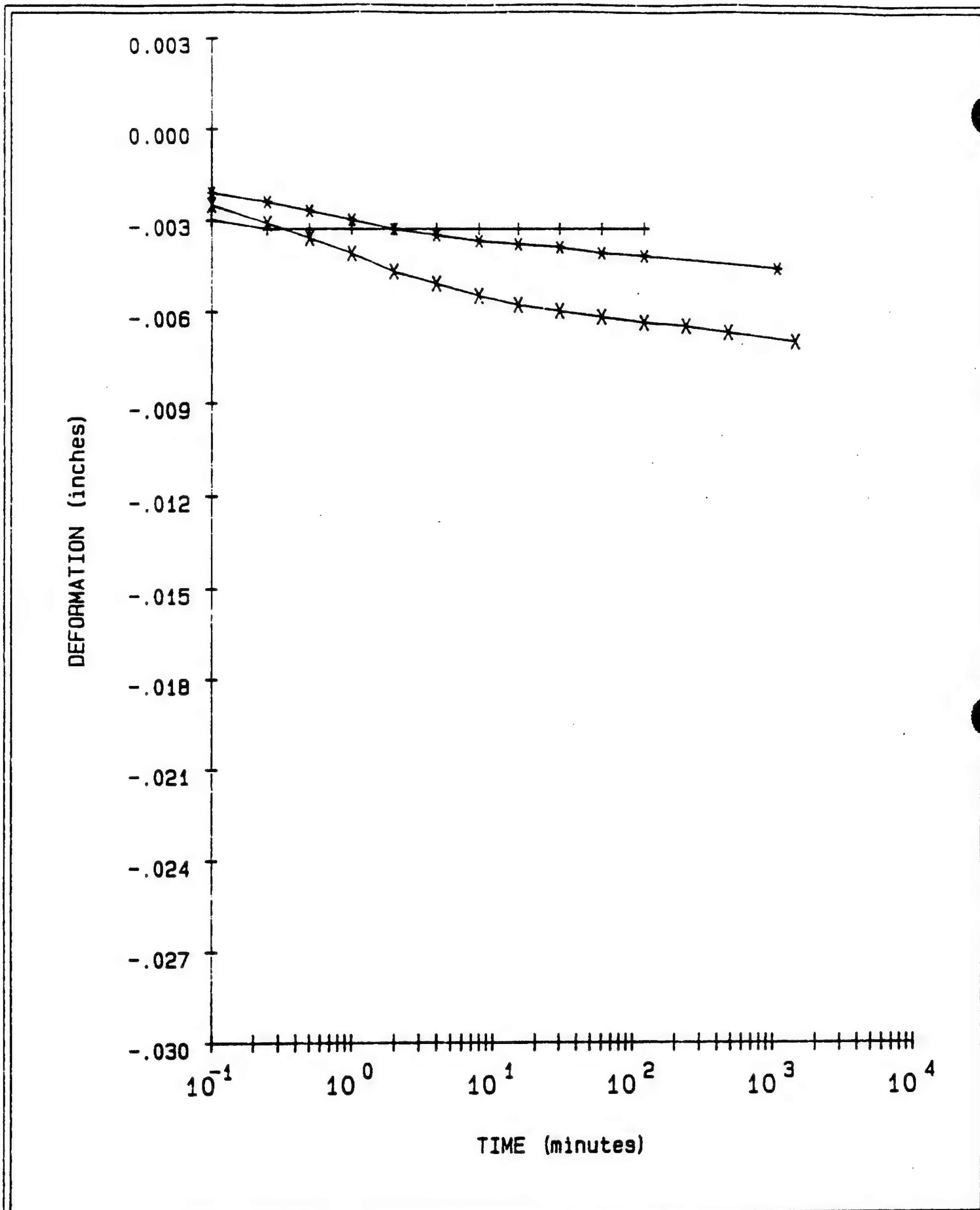


Type of Specimen	UNDISTURBED			Before Test		After Test	
Diam 4.4 in.		Ht 1 in.		Water Content, w_o	30.2 %	w_f	30.2 %
Overburden Pressure, p_o		T/sq ft		Void Ratio, e_o	0.85	e_f	0.79
Preconsol. Pressure, p_c		T/sq ft		Saturation, S_o	97 %	S_f	100 %
Compression Index, C_c				Dry Density, γ_d	91.9 lb/ft^3		
Classification	Fat clay, CH			k_{20} at e_o =	x 10^{-} cm/sec		
LL	52	G_s	2.72	Project	MINNESOTA RIVER; IA-90-04-ED-GH		
PL	20	D_{10}					
Remarks	Medium gray. Torvane=1.6			Area	MRD LAB NO. 90/135		
TSF. Calcareous.				Boring No.	89-130 MU	Sample No.	S-5
				Depth El	42'-44'	Date	
				CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 9

Figure C-537



LEGEND

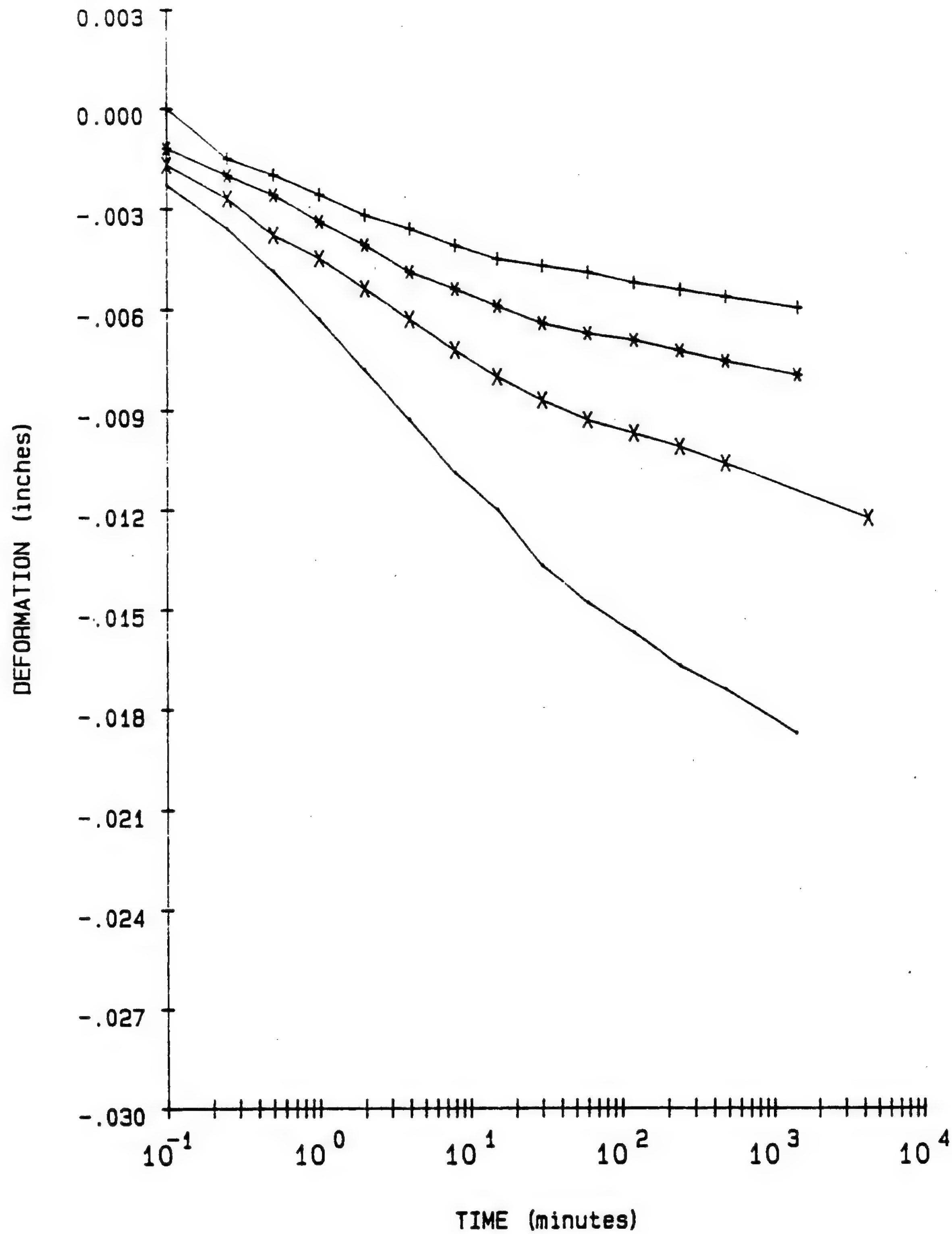
+ = .1 TSF

* = .25 TSF

X = .5 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-5
DEPTH/ELEV	42'-44'
MRD LAB NO.	90/135

FIGURE 10

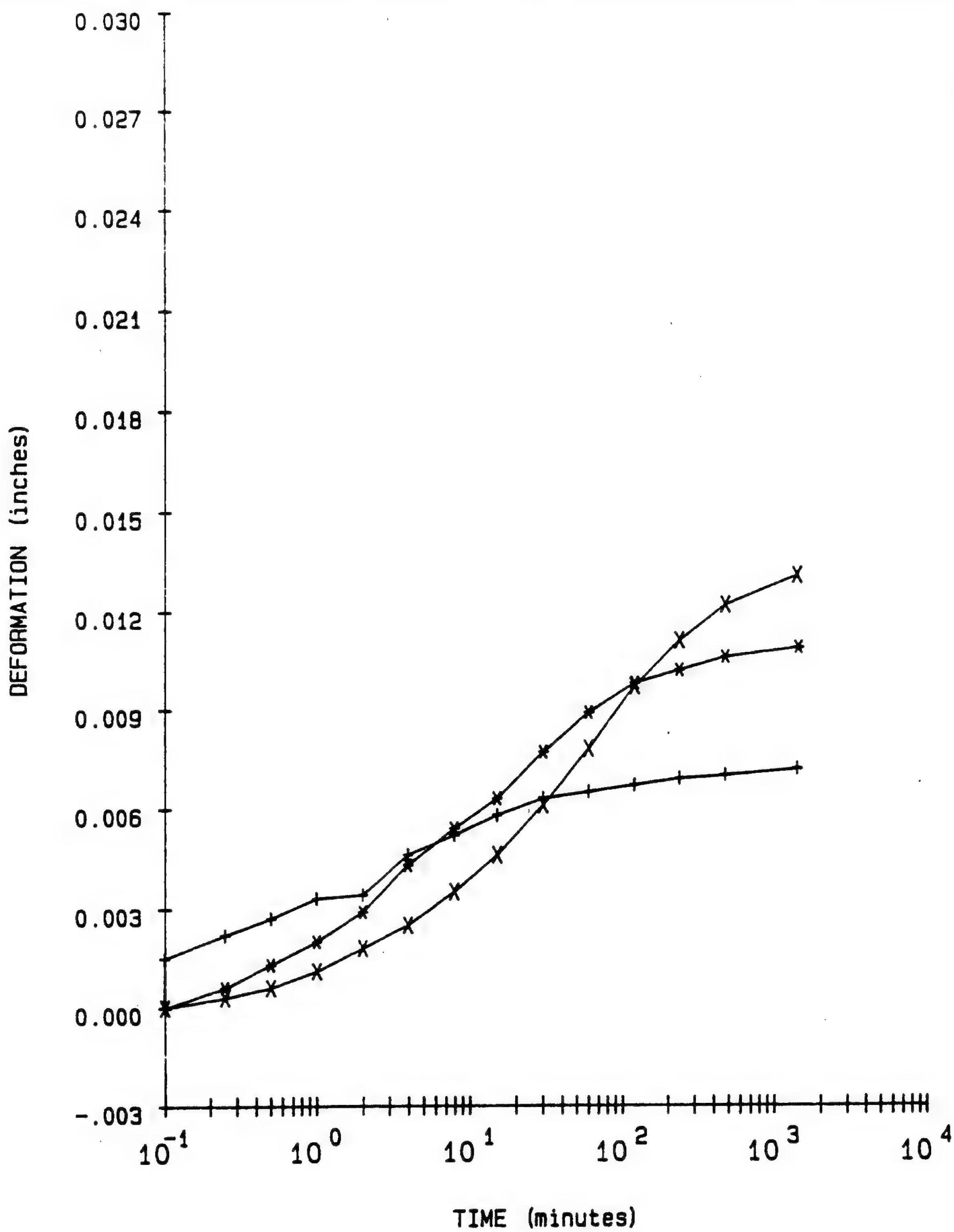


LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-5
DEPTH/ELEV	42'-44'
MRD LAB NO.	90/135

FIGURE 11

Figure C-539



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-5
DEPTH/ELEV	42'-44'
MRD LAB NO.	90/135

FIGURE 12

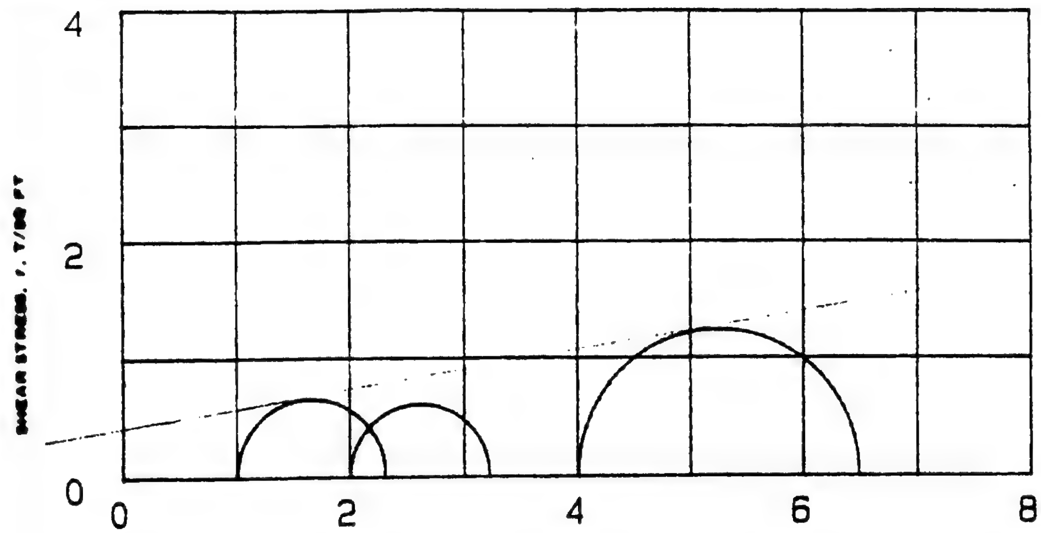
Consolidation Test Data

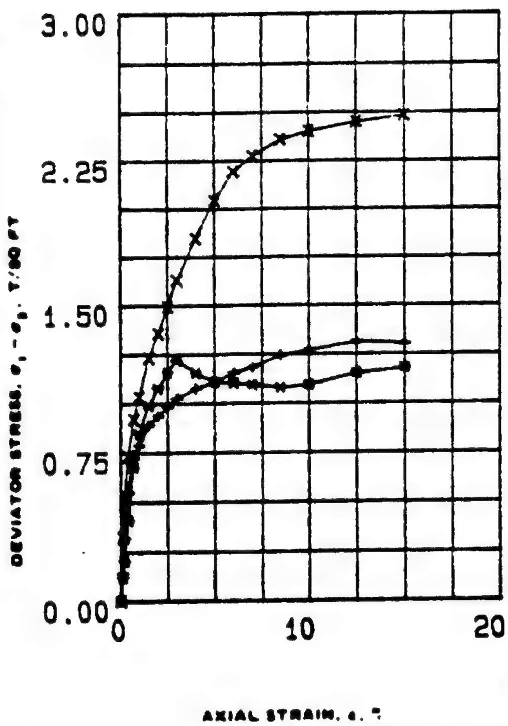
Project	MINNESOTA RIVER; IA-90-04-ED-GH
Boring No.	89-130 MU
Sample No.	S-5
Depth/Elev	42'-44'
MRD Lab No.	90/135

Gs = 2.72
eo = 0.847
0.42eo = 0.356

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
30.2	373.3	91.9	0.847		96.9
30.2	373.3	92.2	0.841	0.10	97.7
30.2	373.3	92.6	0.833	0.25	98.7
30.2	373.3	93.3	0.820	0.50	100.0
30.2	373.3	93.8	0.809	1.00	100.0
30.2	373.3	94.6	0.794	2.00	100.0
30.2	373.3	95.8	0.772	4.00	100.0
30.2	373.3	97.7	0.737	8.00	100.0
0.2	373.3	97.0	0.750	2.00	100.0
30.2	373.3	95.9	0.770	0.50	100.0
30.2	373.3	94.6	0.795	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.829
2	0.810
3	0.792
4	0.773
5	0.755
6	0.736
7	0.718
8	0.699





NORMAL STRESS, σ, T/SQ FT

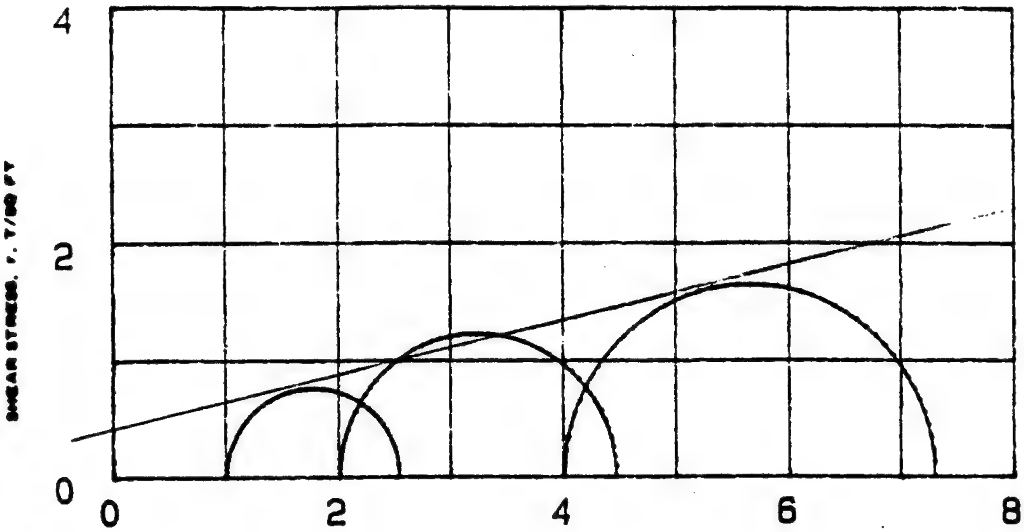
SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	30.8	29.5	28.2	
	DRY DENSITY LB/CU FT	γ_{d_o}	92.5	92.5	9F.4	
	SATURATION, %	S_o	100.0	96.0	98.0	
	VOID RATIO	e_o	0.84	0.84	0.78	
BEFORE SHEAR	WATER CONTENT, %	w_c	30.7	29.5	28.2	
	DRY DENSITY LB/CU FT	γ_{d_c}	92.5	92.7	96.3	
	SATURATION, %	S_c	100.0	96.0	100.0	
	VOID RATIO	e_c	0.84	0.83	0.76	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.0	2.0	4.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.31	1.22	2.48	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	26.8	7.3	33.0	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.30	1.18	2.48	
INITIAL DIAMETER, IN.		D_o	1.42	1.43	1.43	
INITIAL HEIGHT, IN.		H_o	2.99	2.99	2.99	

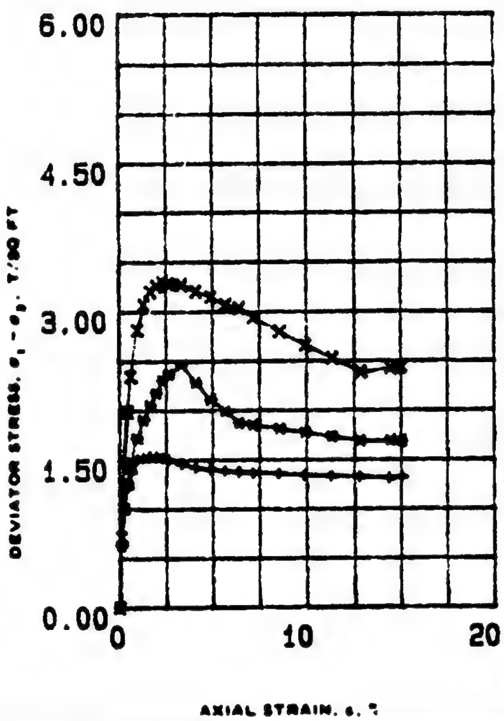
CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH

LL 52	PL 20	PI 32	G_s 2.72	TYPE OF SPECIMEN UNDISTURBED		TYPE OF TEST Q
REMARKS Medium gray. Trovane=1.6 TSF. Calcareous.				PROJECT MINNESOTA RIVER; IA-90-04-ED-GH		
				BORING NO. 89-130 MU		SAMPLE NO. S-5
				DEPTH ELEV 42'-44'		
				LABORATORY 90/135		DATE
				TRIAXIAL COMPRESSION TEST REPORT		

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 13





SPECIMEN NO.			1 (+)	2 (✱)	3 (X)
INITIAL	WATER CONTENT, %	w_o	29.7	30.4	30.8
	DRY DENSITY LB/CU FT	γ_{d_o}	93.8	93.3	91.8
	SATURATION, %	S_o	100	100	98
	VOID RATIO	e_o	.81	.82	.85
BEFORE SHEAR	WATER CONTENT, %	w_c	31.6	32.2	32.2
	DRY DENSITY LB/CU FT	γ_{d_c}	94.7	96.2	96.3
	SATURATION, %	S_c	100	100	100
	VOID RATIO	e_c	.79	.76	.76
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.543	5.543	5.543
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1	2	4
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.532	2.481	3.298
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	180	300	210
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.318	1.677	2.427
INITIAL DIAMETER, IN.		D_o	1.38	1.39	1.38
INITIAL HEIGHT, IN.		H_o	2.88	2.88	2.99

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH B-Value 1.0 1.0 1.0

LL	PL	PI	G:
52	20	32	2.72

TYPE OF SPECIMEN UNDISTURBED TYPE OF TEST RBAR

REMARKS: Medium gray. Torvane=1.6TSF. Calcareous.

PROJECT MINNESOTA RIVER; IA-90-04-ED-SH

BORING NO. 89-130 MU SAMPLE NO. S-5

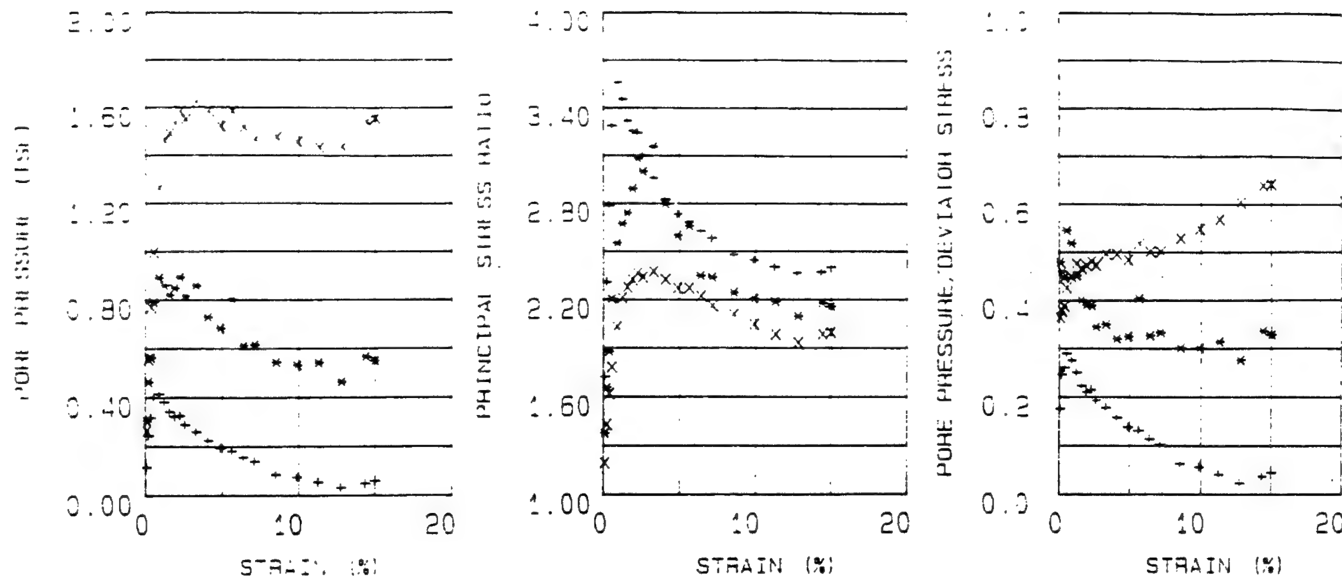
DEPTH ELEV 42'-44'

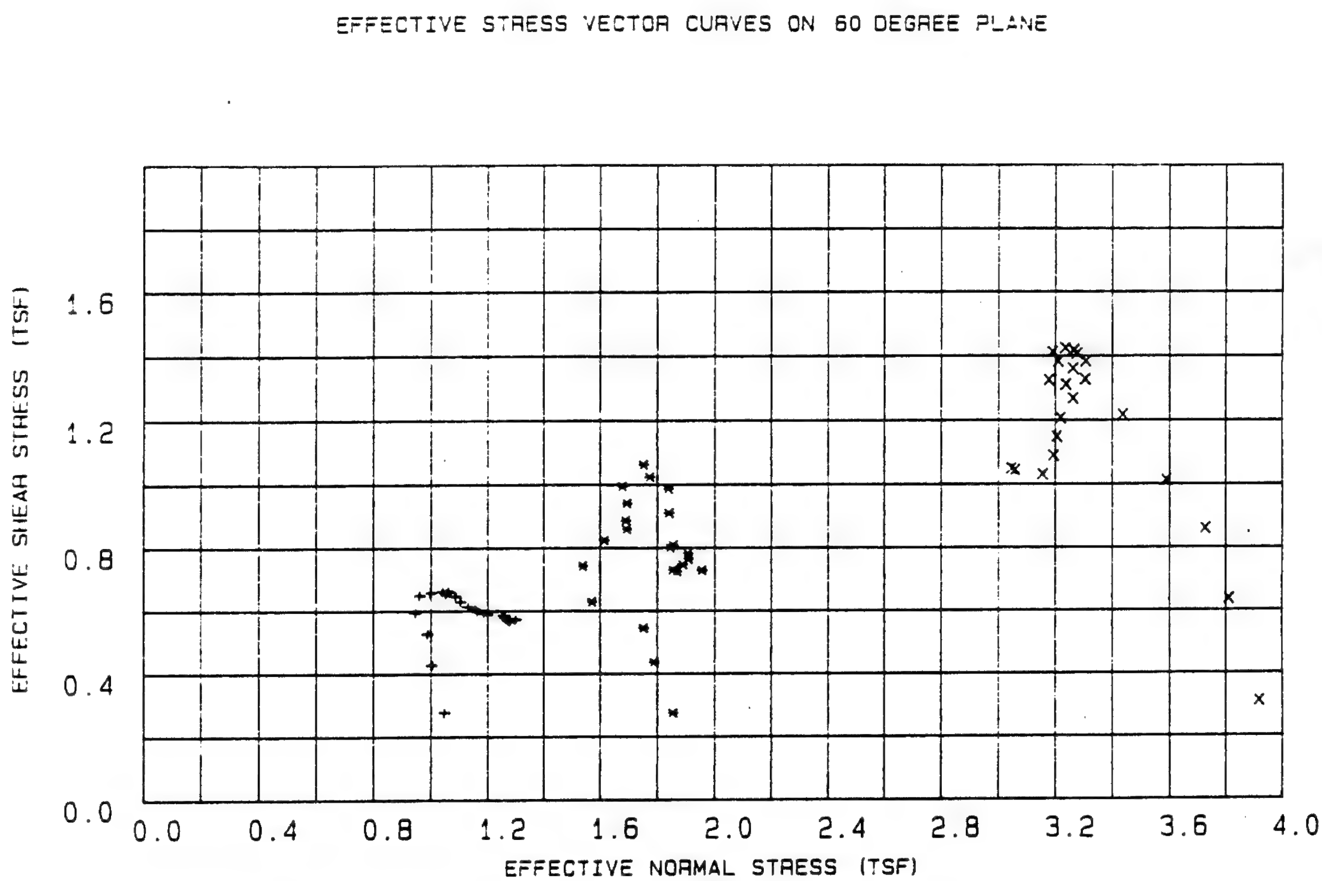
LABORATORY 90/136 DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 14





LEGEND

+ = 1 TSF

* = 2 TSF

X = 4 TSF

PROJECT	MINNESOTA RIVER: IA-90-04-ED-GH
BORING NO.	89-130 MU
SAMPLE NO.	S-5
DEPTH/ELEV	42'-44'
MRD LAB NO.	90/135

FIGURE 15

Table 4 - Triaxial $\bar{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-130 MU
Sample Number : S-5
Depth : 42'-44'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.640	0.112	1.721	0.175	1.047	0.276
30	0.24	0.989	0.243	2.306	0.246	1.002	0.427
45	0.41	1.219	0.316	2.783	0.260	0.986	0.526
60	0.58	1.377	0.397	3.285	0.289	0.944	0.594
90	0.92	1.503	0.412	3.558	0.275	0.960	0.649
120	1.25	1.522	0.379	3.451	0.250	0.998	0.657
150	1.59	1.531	0.339	3.316	0.222	1.040	0.661
180	1.93	1.532	0.320	3.251	0.209	1.059	0.661
210	2.26	1.515	0.324	3.240	0.214	1.051	0.654
240	2.60	1.498	0.287	3.099	0.192	1.084	0.646
300	3.30	1.454	0.257	2.957	0.177	1.103	0.628
[illegible]	4.07	1.418	0.222	2.822	0.157	1.129	0.612
[illegible]	4.86	1.399	0.191	2.729	0.137	1.155	0.604
480	5.61	1.381	0.179	2.682	0.130	1.163	0.596
540	6.36	1.372	0.154	2.623	0.113	1.186	0.592
600	7.10	1.362	0.137	2.579	0.101	1.200	0.588
720	8.50	1.354	0.083	2.476	0.062	1.252	0.584
840	9.85	1.337	0.072	2.442	0.055	1.259	0.577
960	11.25	1.327	0.052	2.400	0.040	1.277	0.573
1080	12.74	1.322	0.029	2.361	0.022	1.298	0.571
1200	14.33	1.306	0.046	2.369	0.036	1.277	0.564
1250	15.00	1.318	0.057	2.398	0.044	1.269	0.569

Table 5 - Triaxial $\bar{R}$ Test Results

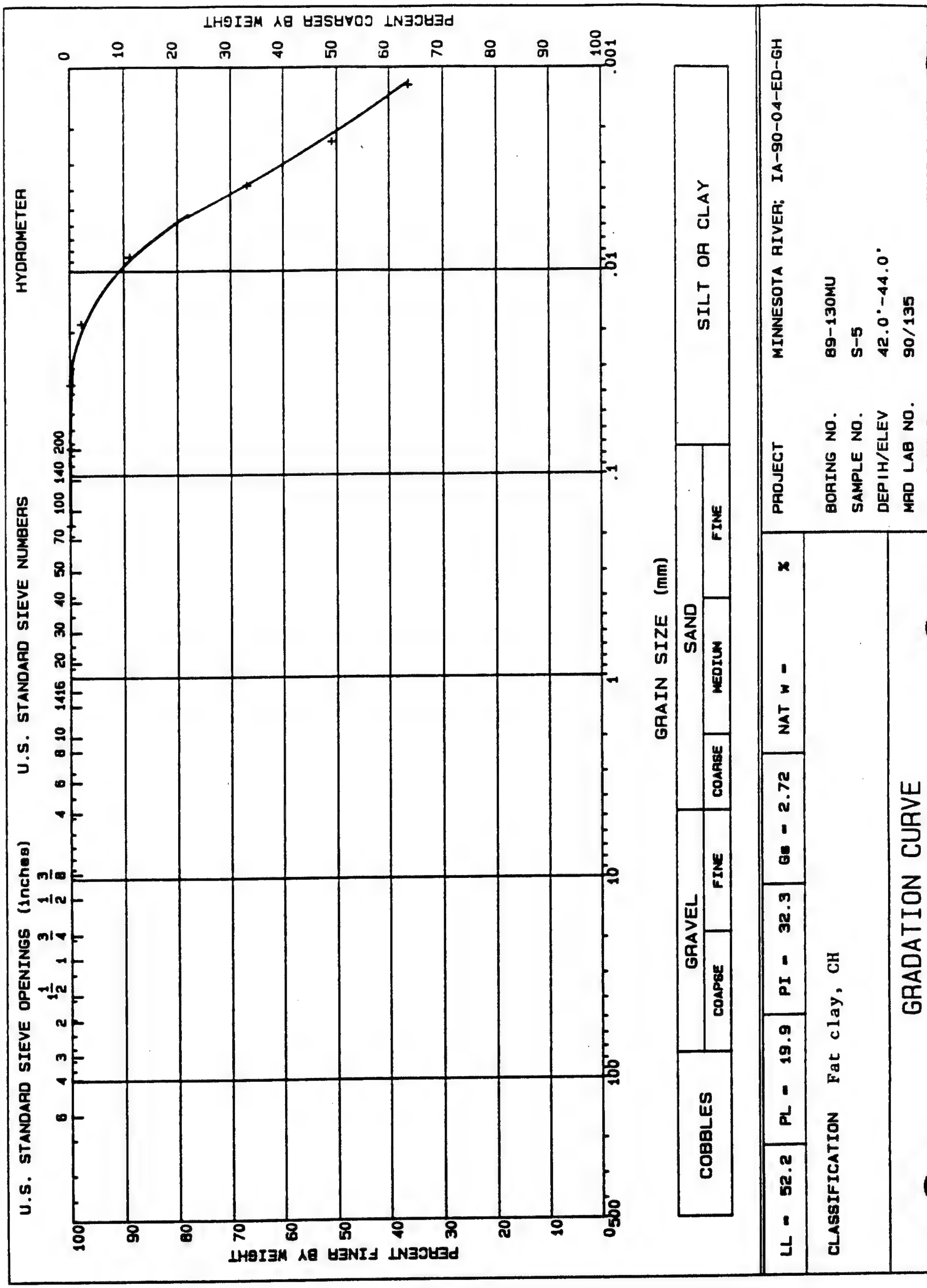
Project	: MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number	: 89-130 MU
Sample Number	: S-5
Depth	: 42'-44'
Confining Pressure	: 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.635	0.304	1.374	0.479	1.853	0.274
30	0.24	1.008	0.462	1.656	0.459	1.788	0.435
45	0.41	1.261	0.561	1.877	0.446	1.751	0.544
60	0.58	1.454	0.791	2.203	0.544	1.569	0.628
90	0.92	1.721	0.890	2.550	0.517	1.536	0.743
120	1.26	1.907	0.858	2.670	0.450	1.614	0.823
150	1.60	2.054	0.819	2.739	0.399	1.689	0.886
180	1.94	2.179	0.847	2.890	0.389	1.693	0.941
210	2.28	2.304	0.893	3.081	0.388	1.677	0.994
240	2.62	2.370	0.814	2.998	0.344	1.773	1.023
300	3.32	2.461	0.858	3.155	0.349	1.751	1.062
360	4.09	2.282	0.727	2.793	0.319	1.838	0.985
420	4.89	2.105	0.681	2.596	0.324	1.840	0.909
480	5.64	1.988	0.800	2.656	0.403	1.692	0.858
5[illegible]	6.39	1.872	0.609	2.346	0.326	1.855	0.808
6[illegible]	7.14	1.850	0.614	2.335	0.332	1.844	0.799
720	8.55	1.809	0.542	2.240	0.300	1.906	0.781
840	9.91	1.769	0.530	2.203	0.300	1.908	0.763
960	11.31	1.728	0.540	2.184	0.313	1.888	0.746
1080	12.81	1.684	0.462	2.095	0.275	1.955	0.727
1200	14.41	1.688	0.565	2.176	0.335	1.853	0.729
1244	15.00	1.677	0.548	2.155	0.327	1.867	0.724

Table 6 - Triaxial $\overline{R}$ Test Results

Project : MINNESOTA RIVER; IA-90-04-ED-GH
Boring Number : 89-130 MU
Sample Number : S-5
Depth : 42'-44'
Confining Pressure : 4 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.715	0.260	1.191	0.364	3.917	0.309
30	0.24	1.471	0.554	1.427	0.377	3.810	0.635
45	0.41	1.989	0.768	1.616	0.387	3.725	0.859
60	0.58	2.344	0.994	1.780	0.425	3.586	1.012
90	0.92	2.817	1.262	2.029	0.448	3.435	1.216
120	1.26	3.072	1.458	2.209	0.475	3.303	1.326
150	1.60	3.201	1.488	2.274	0.465	3.305	1.382
180	1.94	3.258	1.533	2.321	0.471	3.274	1.406
210	2.28	3.296	1.582	2.363	0.480	3.234	1.423
240	2.62	3.281	1.548	2.338	0.472	3.264	1.416
300	3.32	3.268	1.620	2.373	0.496	3.189	1.411
360	4.10	3.200	1.582	2.323	0.495	3.210	1.381
420	4.90	3.148	1.518	2.268	0.483	3.261	1.359
480	5.65	3.065	1.582	2.268	0.517	3.177	1.323
5[illegible]	6.41	3.033	1.514	2.220	0.500	3.237	1.309
6[illegible]	7.16	2.934	1.465	2.158	0.500	3.261	1.266
720	8.56	2.793	1.473	2.105	0.528	3.218	1.205
840	9.92	2.656	1.454	2.043	0.548	3.204	1.147
960	11.33	2.521	1.431	1.981	0.568	3.193	1.088
1080	12.83	2.384	1.435	1.929	0.603	3.155	1.029
1200	14.43	2.417	1.541	1.983	0.638	3.057	1.043
1242	15.00	2.427	1.555	1.993	0.641	3.045	1.048



U.S. STANDARD SIEVE OPENINGS (inches)
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PERCENT FINER BY WEIGHT
PERCENT COARSER BY WEIGHT
GRAIN SIZE (mm)
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
LL = 52.2
PL = 19.9
PI = 32.3
Gs = 2.72
NAT W = %
CLASSIFICATION Fat clay, CH
PROJECT MINNESOTA RIVER; IA-90-04-ED-GH
BORING NO. 89-130MU
SAMPLE NO. S-5
DEPTH/ELEV 42.0'-44.0'
MRD LAB NO. 90/135
GRADATION CURVE
FIGURE 16

Figure C-548

APPENDIX D

STRUCTURAL

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX D

STRUCTURAL

TABLE OF CONTENTS

Item	Page No.	Para. No.
PURPOSE	D-1	1-2
DESIGN CRITERIA		
REINFORCED CONCRETE STRUCTURES	D-1	3-6
MATERIAL PROPERTIES	D-1	7-12
LIVE LOADS	D-2	13-14
UPLIFT	D-3	15-16
PRECAST REINFORCED CONCRETE PIPE	D-3	17
STRUCTURES		
PUMPING STATION	D-3	18-21
OUTLETS	D-4	22-25
INTERCEPTOR STORM SEWER SYSTEM	D-5	26-29
RELIEF WELL SYSTEM	D-5	30
PEDESTRIAN/WHEELCHAIR RAMP	D-6	31
DESIGN COMPUTATIONS	D-6	32-33
SAMPLE DESIGN COMPUTATIONS	D-8 - D-61	
REFERENCES	D-6	34

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX D

STRUCTURAL

PURPOSE

1. This appendix describes the methods used in the analysis and design of the structures for the Chaska Creek Flood Control Project, Chaska, Minnesota. It summarizes references, design criteria, materials and loads for the structure. The design of the major features are described individually.

2. Structural design computations are done to a level of detail to provide accurate quantities for the cost estimate and to assure stability, but not to develop details except for structures where such details are critical. Project features are sufficiently detailed to allow for preparation of the plans and specifications.

DESIGN CRITERIA

REINFORCED CONCRETE STRUCTURES

3. Specified Compressive Strength of Concrete: f'c = 4000 psi

4. Steel reinforcing bars: Grade 60

5. Minimum reinforcement cover - cast-in-place Hydraulic Structures:
Any surface - 2 inches
Concrete surfaces cast against earth or in contact with storm drainage water - 3 inches

6. Reinforcement details are not provided but will be developed in the Plans and Specifications

MATERIAL PROPERTIES

7. Structural grade steel: ASTM A36

8. Aluminum: 6061-T6

9. Steel Sheet Piling: ASTM A328

10. Unit weights: pcf

Concrete - 150
Water - 62.5

11. Soil Unit Weights: pcf

	moist	saturated	submerged
Flotation	115	120	57.5
Lateral Pressure	120	125	62.5
Pervious Backfill for Structures Outside Levee	120	125	62.5

12. Soil Properties

	phi (degrees)	c (psf)
a. Pervious Backfill for Structures Outside Levee	30	0

b. Outlet B - Native Soil in Levee

Elevation	Term	phi	c
Top of levee to 710	Short	0	1200
"	Long	27	0
710 to 680	Long	31	0

c. Outlet C and Pumping Station - Native Soil in Levee

Elevation	Term	phi	c
Top of Levee to 716	Short	0	1200
"	Long	27	0
716 to 714	Short	0	500
	Long	28	0
714 to 710	Short	0	1200
	Long	27	0
710 to 706		28	0
706 to 696		30	0
696 to 670		32	0

LIVE LOADS

13. In the design of vertical walls below grade, loading conditions in some instances include surcharge loads on the ground surface. They are derived based on the heaviest piece of machinery likely to be placed on the fill during construction or operation and maintenance of the structure.

14. The live loads for the operating floors of the pumping station are assumed to be 100 psf plus the heaviest work piece placed anywhere on the floor.

UPLIFT

15. Hydrostatic loading is the conventional triangular distribution of water pressure from the uplift head elevation taken to the desired depth. Uplift head elevation is the general elevation of piezometric head beneath the semi-pervious top blanket as determined by Geotechnical.

Uplift Head Elevation at Toe of Berm	Location
713	From sewer treatment plant to Pine Street. This area has relief wells.
715	From just upstream of last relief well at Pine Street, upstream to the end of the project.
713	Increasing to El. 729 at 150 feet riverward. At pumping station and Outlet C at Oak Street.

16. Three categories of loading conditions are in the analysis of structures for stability against flotation, usual, unusual, extreme. In the condition when the uplift head elevation is above the ground surface, that head above the ground surface is dissipated in the thickness of the semi-pervious top blanket of soil. Therefore the submerged weight of the soil in the semi-pervious layer will be decreased by the hydrostatic pressure at the ground surface caused from the uplift head.

PRECAST REINFORCED CONCRETE PIPE

17. Pipe class is according to ASTM C76 and C 655 and shall meet the strength test requirements under the three-edge-bearing method for the specified D-load to produce a 0.01-inch crack. The factor of safety for pipes in the levee is 2.0.

STRUCTURES

PUMPING STATION

18. The top slab elevation was established for this projects conditions by Mechanical. It has hatches to allow access to the sump for pulling the pumps and for access by ladder to the platform below. The top slab elevation above the forebay area was established at close to ground surface elevation. Steel grated openings in the slab will allow for cleaning the trash racks and removal of sluice gates. Two access hatches are provided with a ladder to the forebay floor below. The sluice gate stems extend to the gate lifters on this slab. The spacing and top elevation of the sump separator walls was determined for proper operation of the pumps by Mechanical. These walls could

have been full height, but they are not needed for support of the top slab. The wall thicknesses were determined using the proper loading conditions for water and soil.

19. The superstructure walls consist of a monolithic reinforced concrete structural frame and brick masonry skin. The roof system will be supported on the concrete walls. Strength and constructibility determine the wall thickness. The pump hoist will run on a monorail beam. The monorail beam will be supported on concrete wall brackets on both ends and near the middle by a steel beam. The steel beam is supported on both ends on concrete wall brackets, also. All member sizes in the superstructure were determined based on experience and not analysis.

20. There are many miscellaneous structural items in the pumping station which are not sized and detailed. The following is a list of most of these: flange back sluice gates with stem and F type thimble, gate lifters, ladders, platform, grating, handrail, hatch covers and trash rack.

21. The pump station was analyzed for stability against flotation. Base slab extensions were used in addition to the weight of the structure to achieve the proper factor of safety. Overturning and sliding were not checked since the difference in ground surface from front to back is only 3 to 5 feet.

OUTLETS

22. There are two gravity outlets on this project. Outlet B is near Chestnut Street and Outlet C is near Oak Street at the pumping station. The outlet consist of a manhole at the interceptor, gravity pipe, gatewell, outlet pipe and sheetpile cutoff wall at the outlet scour hole.

23. The gatewells are located in the levee with the top elevation at top of levee. A sluice gate provides closure from high river water. A bulkhead provides emergency closure. The top slab has hinged steel panels to provide access to the bulkhead area. Steel grating openings will allow removal of sluice gates for maintenance and to allow access to the platforms below by ladder. The wall thicknesses are based on similar gatewells from past designs. The gatewell has access from the top of levee and there are handrails around the top for safety.

24. The crown elevation of the outlet pipes is below the estimated ice line. This established the bottom elevation of the gatewells. The outlet invert elevation is submerged above the bottom of the river channel. The pipe shall have sloped end sections at the outlet. The pipe flexible watertight joints will be bell and spigot with o-ring gaskets.

25. Sheet pile walls are used at the outlet to prevent erosion under the pipes. The top of sheet pile shall conform to the bottom of the pipe to prevent movement of material through the cut-off. The wall is designed as though the soil was eroded away to the elevation of the

bottom of the scour hole. The bottom elevation of the sheetpile below the bottom of the scour hole estimated at a depth of 2 times the height above the bottom of scour hole.

INTERCEPTOR STORM SEWER SYSTEM

26. The system consists of a reinforced concrete pipe (RCP) interceptor sloping to two gravity outlets and a series of manholes and risers. Inlets take surface run-off and feed it into the risers, manhole or interceptor. Any structure or part of this system must be located a minimum of 1-foot landside of the berm toe in order to not interfere with the berm.

27. The manhole could be used for future expansion of the cities storm sewer system. Where ever possible at interceptor pipe size changes, an increaser is used and a RCP tee with a riser to the ground surface. Otherwise RCP manholes were used. RCP bends are mostly used for changes in direction of the pipe. At the two gravity outlets, large cast-in-place manholes are used to accommodate the large pipe.

28. The interceptor pipe, tees with risers, and manholes have some special considerations to prevent flotation. A concrete arch is used over the pipe, when required, for added weight between manholes 1 and 3 and at most of the tee sections. At manholes, larger base slabs were used, when required, in order to use the soil above the base slab as weight to achieve the proper factor of safety.

29. The inlets are rectangular reinforced concrete structures with grated tops to let in surface run-off. Standard cast iron castings are used for long life and economic reasons. Since the inlets are relatively shallow and open to the surface, resisting flotation is difficult. Therefore a minimum of 2 feet of pervious fill with drainage gravel at the ground surface is used around the structure and feeder pipe, which prevents the hydrostatic uplift head elevation from being any higher than the top of the inlet. The wall and slab thicknesses were determined for strength and weight to resist flotation.

RELIEF WELL SYSTEM

30. A 48" diameter manhole houses and protects the tops of the wells located in the levee berm. The top of the stand pipes at Elevation 706 is approximately 7 feet below the top of berm. Water from the well drains into the interceptor through a 12" RCP. An aluminum check valve, rubber gasket, and plastic standpipe are used to allow escape of water and prevent backflooding of surface water. A stainless steel well screen is used because of its corrosion resistance and efficient screen that can be fabricated.

PEDESTRIAN/WHEELCHAIR RAMP

31. The ramp between the top of levee and the pedestrian bridge is designed for handicap access with proper slope, landings and handrails. The portion of the existing timber bridge that would be under the new levee will be removed. This will consist of removing the handrail, planking, beams and two pile bents to a minimum of 3-feet below existing grade.

DESIGN COMPUTATIONS

32. The purpose of the computations is to show loading assumptions, design methods, design criteria and level of detail used in designing the structures. The sample computations shown for the flotation analysis and design of the interceptor and manholes represent the design used for all the structures in the system. Design of the gatewells, outlet and structural steel items were based on experience with other similar projects and no computations are presented for these structures.

33. The structural computations are arranged as shown in the following table of contents.

Item	Page No.
Pumping Station Design	1-19
Inlet Design	20-32
Interceptor Pipe Class Design	33-36
Interceptor and Tee Flotation Analysis	37-48
Manhole Flotation Analysis	49-52
Minimum Angle Between Pipes In Manholes	53-54

REFERENCES

34. Loading conditions, design assumptions and design methods are based on applicable parts of the following references.

a. ACI 318-89 American Concrete Institute, "Building Code Requirements for Reinforced Concrete".

b. AISC, American Institute of Steel Construction, "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings", 9th Edition.

c. American Concrete Pipe Association, "Concrete Pipe Design Manual", 1978.

d. EC 1110-2-267, Strength Design for Reinforced Concrete Hydraulic Structures (31 Jan 90)

e. EM 1110-1-2101, Working Stresses for Structural Design (1 Nov. 63)

f. EM 1110-2-2000, Standard Practice for Concrete (5 Sept 85)

g. EM 1110-2-2102, Waterstops and Other Joint Materials (31 May 83)

h. EM-1110-2-2400, Structural Design of Spillway Outlet Works (2 Nov 64)

i. EM 1110-2-2502, Retaining and Flood Walls (29 Sept 89)

j. EM 1110-2-2902, Conduits, Culverts and Pipes (Mar 1969)

k. EM 1110-2-2906, Design of Pile Structures and Foundations (July 1969 and Nov 1970)

l. EM 1110-2-3104, Structural & Architectural Design of Pumping Stations (30 June 89)

m. ETL 1110-2-256, Sliding Stability for Concrete Structures (June 1981)

n. ETL 1110-2-307, Flotation Stability Criteria for Concrete Hydraulic Structures (Aug 1987)

o. Engineering Monograph No. 27, Moments and Reactions for Rectangular Plates, by W.T. Moody, U.S. Bureau of Reclamation.

p. Uniform Federal Accessibility Standards, FED-STD-795, 1 Apr 88

NRH 12/27/90

✓ GRS 1/91

Pump Station

Determine Wall thickness

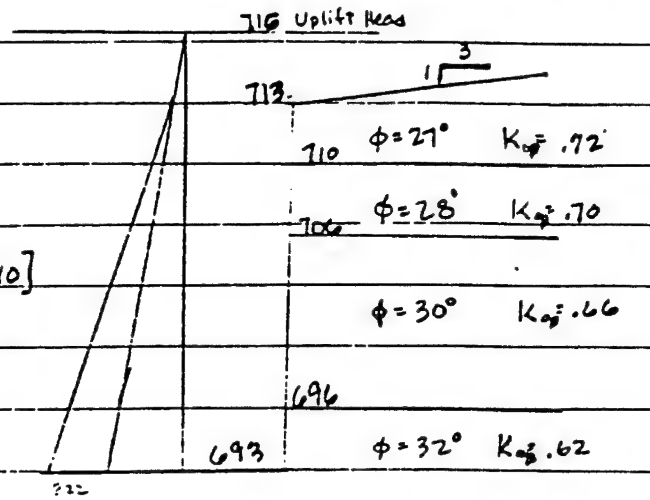
Uplift head 28' from berm toe

$H = \frac{28'}{150'} \times 16' + 713 = 716$

Use for pump chamber walls

$K_{op} = (1 - \overset{K_o}{\sin \phi})(1 + \sin \beta)$ [EM 1110-2-2502, 3-10]

$\gamma_{sat} = 125$ pcf



El. 713:

$p = (62.5)(3') = 187.5$ psf

El. 710:

$p = p_{713} + [62.5 + (.72)(125 - 62.5)](3') = 187.5 + 322.5 = 510$ psf

El. 706:

$p = p_{710} + [62.5 + (.70)(125 - 62.5)](4') = 510 + 425 = 935$ psf

El. 696:

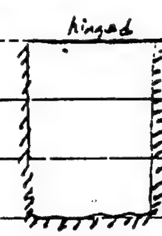
$p = p_{706} + [62.5 + (.66)(125 - 62.5)](10') = 935 + 1037.5 = 1972.5$ psf

El. 693:

$p = p_{696} + [62.5 + (.62)(125 - 62.5)](3') = 1972.5 + 303.75 = 2276$ psf

REFERENCE: MONOGRAPH OF TABLES USED FOR RECTANGULAR PLATES + SLAB - MOMENT + SHEAR COEFF.

Side Walls of sump area: hinge top because of large openings.



Fixed on 3 sides

$a/b = \frac{15/2}{20.5} = .37$, $x/a = 0$, $y/b = .6 \not{,} .4$, M_x

Figure 10 ($\overset{max.}{coeff}$): Mom $= \overset{.0403}{.0374}$ Reaction $= \overset{.3624}{.3427}$ $y/b = .4$ shear $x/a = 1.0$

Figure 13 ($\overset{max}{coeff.}$): Mom $= \overset{.0170}{.0207}$ Reaction $= \overset{.2120}{.2647}$

$Max.\ M = \overset{(.0374)}{(.0403)}(1.875)(20.5)^2 + \overset{(.0207)}{(.0170)}(2.089)(20.5)^2 = \overset{21.12}{18.10}\ ^{1K} \leftarrow = .254^{11K}$

$M_u = 1.7 \times 1.3 \times 254^{11K} = 560^{11K}$ Hydraulic Structure EM-1110-2-xxxx

$\rho_{max} = .25 \rho_b = .007126 = \frac{A_s}{bh}$, 18" wall $A_{s\,max} = .007126 \times 12 \times 18 = 1.54$ in²/'

$\phi M_n = \phi f_y A_s \left(d - \frac{A_s f_y}{1.7 b f'_c}\right) = (.9)(60)(1.5)\left[14.5 - \frac{(1.5)(60)}{(1.7)(2)(4)}\right] = 1085^{11K} > 560^{11K}$ (ok)

NRH 12/27/90

Pump Station

✓GRS 1/91

Determine wall thickness (con't)

(.3624) (.2120) = 10.47^k

Max. Shear = (.3421)(.1875)(20.5) + (.2647)(2.089)(20.5) = 12.65^k ←

V @ d out from support = $12.65 - [(.1875) + (1.965) + (\frac{1}{2})(.123)](\frac{14.5}{12}) = 12.65 - 2.68 = 9.97^k$

$V_u = 1.7 \times 1.3 \times 9.97^k = 22.0^k$

Try 21" wall d = 21 - 3.5 = 17.5"

$\phi V_c = \phi d b 2\sqrt{f'_c}$ (4000) = (.85)(12)(16.5)(.126) = $22.6^k \sim 22.0^k$ (ok) 21" wall min.

Use 24" wall - exterior side pump chamber walls

(Need extra wt. for uplift.)

Determine exterior endwall thickness for sump area.

SPAN HORIZONTALLY 5' BETW. WALLS

Neg. moment, $\frac{1}{12} w l^2$ do at 12" above floor

$w = 2.175^{k/'}$, $l = 5'$ clear span

$M_{max} = (\frac{1}{12})(2.175)(5)^2 = 4.53'^k = 54.4''^k$

$M_u = 1.7 \times 1.3 \times 54.4 = 120''^k$; $\rho_{max} = .75\rho_b = .007126$ Try h = 14", d = 10.5"

$\phi M_n = \phi \rho f_y b d^2 (1 - \frac{\rho f_y}{1.7 f'_c}) = (.9)(.007126)(60)(1 - \frac{(.007126)(60)}{(1.7)(4)})(12)(8.5)^2 = 312''^k > 120''^k$ (ok) for 14" wall

$V = (2.175)(\frac{5}{2}) = 5.44^k$, $V_u = 1.7 \times 1.3 \times 5.44 = 12^k$

$\phi V_n = (.85)(.126)(12)(10.5) = 13.5^k > 12^k$ (ok)

Span horizontally 18' above El. 706.5

Neg. moment $\frac{1}{12} w l^2$ take load at El. 706

w = (from load diagram on previous sheet) $.935^{k/'}$, $l = 18'$ clear span

$M_{max} = (\frac{1}{12})(.935)(18)^2 = 25.25'^k = 303''^k$

$M_u = 1.7 \times 1.3 \times 303''^k = 670''^k$ $\rho_{max} = .007126$

$\phi M_n = (.9)(.007126)(60)(1 - \frac{(.007126)(60)}{(1.7)(4)})(12) d^2 = 4.33 d^2$

Try 16" wall d = 16 - 3.5 = 12.5"

$\phi M_n = 4.33 (12.5)^2 = 676''^k > 670''^k$ (ok)

NRH 12/28/90

✓GRS 1/91

Pump Station

Wall thickness (unit)

$V = (.935)(\frac{18}{2}) = 8.42^k$

$\phi V_c = (.85)(.126)(12)\, d = 1.29\, d$

Assume 16" wall $d = 12.5"$

$V_{@\, d\, out} = 8.42 - (\frac{12.5}{12})(.935) = 8.42 - .97 = 7.45$

$V_u = 7.45 \times 1.7 \times 1.3 = 16.5^k$

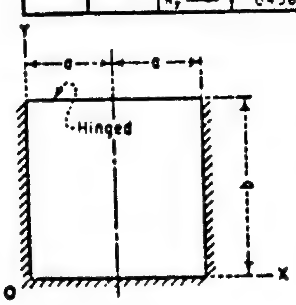
$\phi V_c = 1.29(12.5) = 16.2^k \sim 16.5$ (ok) 16" wall

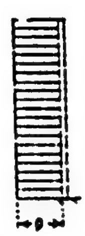
Use 24" wall exterior area at pump chamber. need for weight.

Use 16" min wall thickness for exterior walls (Structure above is 16" wall)

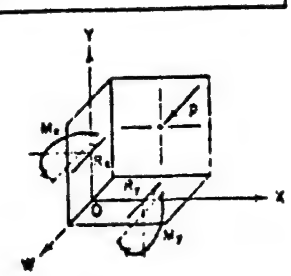
Walls > 10' high min 14" thick

	y/b	x/a →	M_x 0	M_x 0.2	M_x 0.4	M_x 0.6	M_x 0.8	M_x 1.0	M_y 0	M_y 0.2	M_y 0.4	M_y 0.6	M_y 0.8	M_y 1.0
a/b = 1/8		$R_x \diagdown R_y$	+.0063	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
	1.0	+.0063	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.1242	+.0049	+.0021	[illegible]	-.0013	-.0022	-.0025	+.0010	+.0004	-.0001	-.0004	-.0006	-.0007
	0.6	+.1254	+.0052	+.0023	-.0002	-.0014	-.0023	-.0027	+.0010	+.0005	+.0000	-.0003	[illegible]	-.0006
	0.4	+.1253	+.0051	+.0023	+.0002	-.0014	-.0023	-.0027	+.0010	+.0005	+.0000	-.0003	-.0005	-.0006
	0.2	+.1185	+.0048	+.0021	+.0001	-.0013	-.0021	-.0025	+.0010	+.0004	-.0001	-.0004	-.0006	-.0007
	0	+.0504	0	+.0001	+.0003	+.0005	+.0006	+.0007	0	+.0006	+.0016	+.0025	+.0031	+.0033
		R_y →	+.0504	+.012[illegible]	[illegible]	[illegible]	+.1587	+.1[illegible]46						
a/b = 1/4		$R_x \diagdown R_y$	-.0097	[illegible]	[illegible]	+.1482	+.1725	[illegible]						
	1.0	-.0097	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.2366	+.0165	+.0067	-.0002	-.0047	-.0073	-.0081	+.0033	+.0039	-.0011	-.0026	-.0036	-.0039
	0.6	+.2557	+.0201	+.0058	+.0003	-.0056	-.0091	-.0102	+.0040	+.0016	-.0003	-.0018	-.0027	-.0030
	0.4	+.2530	+.0136	+.0085	-.0002	-.0055	-.0089	-.0099	+.0039	+.0015	-.0004	-.0019	-.0025	-.0032
	0.2	+.1908	+.0139	+.0053	-.0003	-.0039	-.0059	-.0065	+.0028	+.0027	-.0011	-.0024	-.0032	-.0035
	0	+.0295	0	+.0005	+.0013	+.0020	+.0025	+.0027	0	+.0024	+.0063	+.010[illegible]	+.0126	+.0135
		R_y →	+.0255	+.0235	+.1131	+.1785	+.2176	+.2324						
a/b = 3/8		$R_x \diagdown R_y$	-.0466	+.06[illegible]	[illegible]	+.1923	+.2327	[illegible]						
	1.0	-.0466	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.3265	+.0301	+.0109	-.0015	-.0089	-.0130	-.0143	+.0060	+.0006	-.0038	-.0073	-.0095	-.0102
	0.6	+.3619	+.0403	+.0161	-.0007	-.0116	-.0177	-.0197	+.0081	+.0023	-.0029	-.0068	-.0094	-.0103
	0.4	+.3624	+.0374	+.0148	-.0003	-.0108	-.0163	-.0181	+.0075	+.0020	-.0028	-.0065	-.0089	-.0097
	0.2	+.2164	+.0211	+.0075	-.0010	-.0059	-.0095	-.0092	+.0042	+.0008	-.0019	-.0038	-.0048	-.0052
	0	-.0013	0	+.0010	+.0027	+.0043	+.0054	+.0058	0	+.0051	+.0135	+.0215	+.0269	+.0289
		R_y →	-.0013	[illegible]	+.1684	+.2653	+.3238	+.3427						
a/b = 1/2		$R_x \diagdown R_y$	-.0902	-.0050	+.1570	+.2529	+.3034	+.3192						
	1.0	-.0902	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.3904	+.0412	+.0128	-.0035	-.0126	-.0172	-.0196	+.0052	-.0005	-.0053	-.0143	-.0180	-.0192
	0.6	+.4751	+.0572	+.0197	-.0036	-.0172	-.0242	-.0263	+.0114	+.0013	-.0083	-.0159	-.0207	-.0224
	0.4	+.4302	+.0508	+.0173	-.0033	-.0152	-.0212	-.0250	+.0102	+.0011	-.0072	-.0137	[illegible]	-.0191
	0.2	+.2047	+.0246	+.0078	-.0017	-.0055	-.0086	-.0092	+.0049	+.0009	-.0017	-.0030	-.0036	-.0037
	0	-.0270	0	+.0019	+.0050	+.0078	+.0096	+.0102	0	+.0094	+.0245	+.0359	+.0480	+.0512
		R_y →	-.0270	+.0571	+.2350	+.3590	+.4297	+.4625						
a/b = 3/4		$R_x \diagdown R_y$	-.1465	+.0482	+.2410	+.3343	+.3758	+.3874						
	1.0	-.1465	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.4415	+.0490	+.0086	-.0030	-.0163	-.0189	-.0196	+.0098	-.0060	-.0197	-.0296	-.0354	-.0373
	0.6	+.5465	+.0545	+.0142	-.0116	-.0225	-.0255	-.0274	+.0135	-.0054	-.0235	-.0366	-.0447	-.0473
	0.4	+.4698	+.0594	+.0121	-.0037	-.0165	-.0214	-.0221	+.0119	-.0039	-.0177	-.0277	-.0334	-.0353
	0.2	+.1759	+.0257	+.0053	-.0029	-.0051	-.0052	-.0050	+.0051	+.0013	+.0005	+.0021	+.0034	+.0040
	0	-.0530	0	+.0041	+.0098	+.0144	+.0171	+.0190	0	+.0207	+.0452	+.0719	+.0854	+.0938
		R_y →	-.0530	+.14[illegible]	+.3055	+.4969	+.5644	+.5[illegible]						
a/b = 1		$R_x \diagdown R_y$	-.1593	+.1304	+.3059	+.3709	+.3922	+.3959						
	1.0	-.1593	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.4456	+.0465	+.0014	-.0129	-.0164	-.0166	-.0154	+.0093	-.0125	-.0294	-.0403	-.0461	-.0473
	0.6	+.5491	+.0664	+.0037	-.0174	-.0225	-.0227	-.0224	+.0133	-.0137	-.0363	-.0512	-.0592	-.0617
	0.4	+.4658	+.0562	+.0031	-.0142	-.0176	-.0172	-.0165	+.0112	-.0101	-.0265	-.0367	-.0418	-.0434
	0.2	+.1622	+.0237	+.0018	-.0033	-.0027	-.0014	-.0006	+.0047	+.0015	+.0035	+.0069	+.0095	[illegible]
	0	-.0584	0	+.0067	+.0139	+.0187	+.0211	+.0219	0	+.0334	+.0697	+.0934	+.1056	+.1093
		R_y →	-.0584	+.2373	+.4659	+.5707	+.6[illegible]	[illegible]						
a/b = 3/2		$R_x \diagdown R_y$	-.1387	+.2509	+.3566	+.3870	+.3970	+.[illegible]59						
	1.0	-.1387	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.4399	+.0368	-.0096	-.0152	-.0143	-.0129	-.0124	+.0074	-.0232	-.0420	-.0505	-.0538	-.0547
	0.6	+.5302	+.0531	-.0110	-.0207	-.0181	-.0169	-.0162	+.0106	-.0239	-.0533	-.0648	-.0693	-.0704
	0.4	+.4497	+.0447	-.0030	-.0160	-.0139	-.0118	-.0111	+.0089	-.0211	-.0316	-.0445	-.0458	-.0474
	0.2	+.1568	+.0184	-.0020	-.0018	+.0007	+.0021	+.0025	+.0037	+.0028	+.0082	+.0125	+.0147	+.0153
	0	-.0456	0	+.0119	+.0192	+.0225	+.0226	+.0235	0	+.0576	+.0959	+.1123	+.1160	+.1154
		R_y →	-.0456	+.3937	+.5702	+.6160	+.6244	+.6[illegible]						





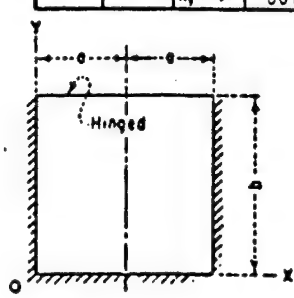
Moment = (Coefficient)(pb^2)
Reaction = (Coefficient)(pb)

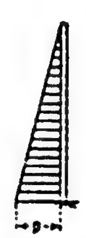


POSITIVE SIGN CONVENTION

FIGURE 10.—*Plate fixed along three edges—Hinged along one edge, moment and reaction coefficients. Load I, uniform load.*

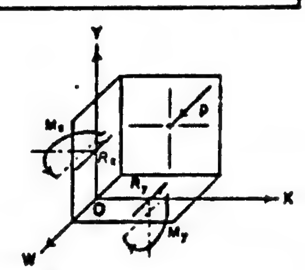
a/b	y/b	x/a →	M_x 0	M_x 0.2	M_x 0.4	M_x 0.6	M_x 0.8	M_x 1.0	M_y 0	M_y 0.2	M_y 0.4	M_y 0.6	M_y 0.8	M_y 1.0
a/b = 1/8		$R_x \diagdown R_y$	-.0003	+.0024	+.0064	+.0092	+.0109	+.0114						
	1.0	-.0003	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.0250	+.0010	+.0005	+.0000	-.0003	-.0005	-.0005	+.0002	+.0001	+.0000	-.0001	-.0001	-.0001
	0.6	+.0500	+.0021	+.0009	+.0001	-.0006	-.0009	-.0011	+.0004	+.0002	+.0000	-.0001	-.0002	-.0002
	0.4	+.0752	+.0031	+.0014	+.0001	-.0008	-.0014	-.0016	+.0006	+.0005	+.0000	-.0002	-.0003	-.0003
	0.2	+.0941	+.0038	+.0016	+.0000	-.0010	-.0017	-.0019	+.0008	+.0005	-.0001	-.0003	-.0005	-.0006
	0	+.0459	0	+.0001	+.0003	+.0005	+.0006	+.0006	0	+.0005	+.0014	+.0023	+.0028	+.0030
		R_y →	+.0459	+.0139	+.0546	+.0835	+.1003	+.1059						
a/b = 1/4		$R_x \diagdown R_y$	-.0061	-.0102	+.0056	+.0169	+.0237	+.0260						
	1.0	-.0061	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.0505	+.0042	+.0019	+.0001	-.0011	-.0019	-.0021	+.0008	+.0004	+.0000	-.0002	-.0004	-.0005
	0.6	+.1020	+.0082	+.0037	+.0002	-.0023	-.0037	-.0042	+.0016	+.0007	-.0000	-.0006	-.0010	-.0011
	0.4	+.1517	+.0114	+.0049	+.0000	-.0032	-.0051	-.0057	+.0023	+.0005	-.0004	-.0013	-.0019	-.0021
	0.2	+.1495	+.0102	+.0037	-.0004	-.0030	-.0043	-.0047	+.0020	+.0004	-.0011	-.0022	-.0029	-.0031
	0	+.0304	0	+.0004	+.0010	+.0016	+.0020	+.0021	0	+.0020	+.0052	+.0081	+.0100	+.0107
		R_y →	+.0304	[illegible]	+.1052	+.1563	+.1956	+.1950						
a/b = 3/8		$R_x \diagdown R_y$	-.0205	-.0283	+.0070	+.0313	+.0455	[illegible]						
	1.0	-.0205	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.0788	+.0091	+.0039	+.0001	-.0026	-.0041	-.0046	+.0018	+.0007	-.0003	-.0010	-.0015	-.0016
	0.6	+.1550	+.0170	+.0070	-.0001	-.0048	-.0075	-.0084	+.0034	+.0011	-.0009	-.0025	-.0035	-.0038
	0.4	+.2120	+.0207	+.0078	-.0028	-.0061	-.0089	-.0098	+.0041	+.0005	-.0021	-.0044	-.0058	-.0063
	0.2	+.1696	+.0145	+.0045	-.0012	-.0042	-.0057	-.0061	+.0029	+.0001	-.0023	-.0039	-.0049	-.0052
	0	+.0102	0	+.0008	+.0020	+.0030	+.0036	+.0040	0	+.0039	+.0099	+.0153	+.0188	+.0200
		R_y →	+.0102	+.0475	+.1490	+.2157	+.2528	+.2647						
a/b = 1/2		$R_x \diagdown R_y$	-.0396	-.0396	+.0153	+.0508	+.0704	+.0767						
	1.0	-.0396	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.1042	+.0139	+.0053	-.0005	-.0041	-.0060	-.0067	+.0028	+.0006	-.0014	-.0030	-.0040	-.0044
	0.6	+.1956	+.0245	+.0097	-.0013	-.0073	-.0104	-.0114	+.0049	+.0008	-.0031	-.0062	-.0082	-.0089
	0.4	+.2450	+.0269	+.0085	-.0023	-.0081	-.0100	-.0113	+.0054	+.0001	-.0048	-.0085	-.0108	-.0116
	0.2	+.1632	+.0159	+.0039	-.0019	-.0044	-.0054	-.0057	+.0032	-.0003	-.0029	-.0043	-.0050	-.0052
	0	-.0040	0	+.0014	+.0033	+.0050	+.0060	+.0064	0	+.0068	+.0167	+.0250	+.0302	+.0320
		R_y →	-.0040	+.0762	+.1559	[illegible]	+.3102	+.3225						
a/b = 3/4		$R_x \diagdown R_y$	-.0671	-.0273	+.0454	+.0834	+.1010	+.1051						
	1.0	-.0671	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.1275	+.0181	+.0044	-.0026	-.0058	-.0071	-.0074	+.0036	-.0008	-.0051	-.0085	-.0106	-.0113
	0.6	+.2274	+.0301	+.0065	-.0048	-.0097	-.0115	-.0119	+.0060	-.0019	-.0094	-.0150	-.0185	-.0196
	0.4	+.2616	+.0302	+.0051	-.0055	-.0095	-.0107	-.0109	+.0060	-.0030	-.0106	-.0158	-.0188	-.0198
	0.2	+.1479	+.0155	+.0017	-.0027	-.0035	-.0033	-.0032	+.0031	-.0011	-.0027	-.0027	-.0023	-.0021
	0	-.0155	0	+.0028	+.0060	+.0083	+.0097	+.0101	0	+.0138	+.0299	+.0417	+.0484	+.0505
		R_y →	-.0155	+.1405	+.2734	+.3424	+.3739	+.3828						
a/b = 1		$R_x \diagdown R_y$	-.0764	+.0024	+.0716	+.0955	+.1081	+.1102						
	1.0	-.0764	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.1300	+.0177	+.0016	-.0043	-.0060	-.0062	-.0061	+.0035	-.0028	-.0086	-.0127	-.0150	-.0153
	0.6	+.2289	+.0299	+.0019	-.0074	-.0097	-.0099	-.0096	+.0058	-.0054	-.0149	-.0213	-.0248	-.0259
	0.4	+.2583	+.0280	+.0006	-.0076	-.0089	-.0086	-.0084	+.0056	-.0064	-.0152	-.0203	-.0228	-.0235
	0.2	+.1417	+.0137	-.0003	-.0027	-.0022	-.0015	-.0012	+.0027	-.0016	-.0019	-.0008	+.0003	+.0007
	0	-.0149	0	+.0042	+.0091	+.0104	+.0115	+.0119	0	+.0211	+.0403	+.0519	+.0576	+.0593
		R_y →	-.0149	+.2003	+.3255	+.3751	+.3944	+.3958						
a/b = 3/2		$R_x \diagdown R_y$	-.0743	+.0499	+.0971	+.1058	+.1058	+.1053						
	1.0	-.0743	0	0	0	0	0	0	0	0	0	0	0	0
	0.8	+.1257	+.0145	-.0025	-.0055	-.0052	-.0046	-.0044	+.0025	-.0067	-.0134	-.0169	-.0183	-.0187
	0.6	+.2208	+.0232	-.0046	-.0089	-.0091	-.0072	-.0069	+.0046	-.0118	-.0223	-.0273	-.0292	-.0297
	0.4	+.2503	+.0219	-.0052	-.0082	-.0071	-.0061	-.0058	+.0044	-.0123	-.0207	-.0240	-.0251	-.0253
	0.2	+.1461	+.0101	-.0022	-.0018	-.0005	+.0002	+.0004	+.0020	-.0019	-.0002	+.0017	+.0026	+.0029
	0	-.0018	0	+.0068	+.0106	+.0121	+.0126	+.0127	0	+.0339	+.0550	+.0606	+.0631	+.0637
		R_y →	-.0018	+.2662	+.3754	+.3960	+.3994	+.3997						





Moment = (Coefficient)(pb^2)

Reaction = (Coefficient)(pb)



POSITIVE SIGN CONVENTION

FIGURE 13.—*Plate fixed along three edges—Hinged along one edge, moment and reaction coefficients, Load IV, uniformly varying load.*

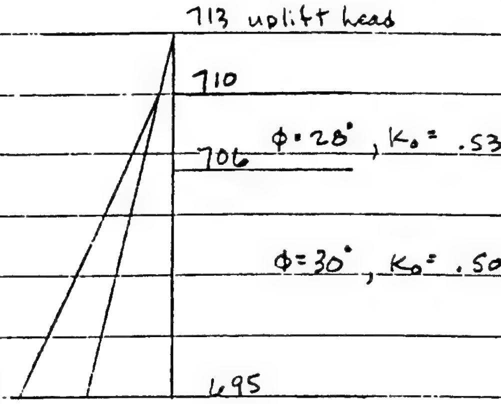
NRH 12/31/90

✓GRS 1/91

Pump Station

Determine Wall Thickness

Forebay   end wall



$K_o = 1 - \sin\phi$

$\gamma_{sat} = 125$ pcf

El. 710:

$p = (62.5)(3') = 187.5$ psf

709: $p = 187.5 + 95.5 = 283$

El. 706:

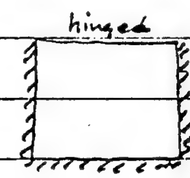
$p = p_{710} + [62.5 + (.53)(125-62.5)](4') = 187.5 + 382.5 = 570$ psf

El. 695:

$p = p_{706} + [62.5 + (.50)(125-62.5)](11') = 570 + 1030 = 1600$ psf

Reference: Monograph of Tables used for rectangular plates + slabs - moment + shear coeff.

Hinged at top because of large openings, fixed 3 sides.



$a/b = \frac{18/2}{14} = .64$, figure 10 + 13 for worst case.

Reactions - worst case: R_y @ $\frac{x}{a} = 1.0$

figure 10: $R_y = .5304$

figure 13: $R_y = .3563$

Max Shear $= [(.5304)(.283) + (.3563)(1.317)](14) = 8.67^k$ assume 16", d = 12.5"

V @ d out from support $= 8.67 - [(.283) + 1.219 + (\frac{1}{2})(.098)](\frac{12.5}{12}) = 8.67 - 1.62 = 7.05^k$

$V_u = 1.7 \times 1.3 \times 7.05^k = 15.6^k$

$\phi V_c = 1.29(12.5) = 16.2^k > 15.6^k$ (ok) 16" min wall

use 24"   Moments - worst case: M_y @ $x/a = 1.0$, $y/b = 0$

figure 10: $M_y = .0728$; figure 13: $M_y = .0424$

Max. Mom. $= [(.0728)(.283) + (.0424)(1.317)](14)^2 = 14.97^{'k} = 180^{''k}$

$M_u = 1.7 \times 1.3 \times 180 = 397^{''k}$ Hydraulic Structure EM 1110-2-XXXX

$\rho_{max} = .25\rho_b = .007126$ 16" wall, d = 12.5"

$\phi M_n = \phi \rho f_y (1 - \frac{\rho f_y}{1.7 f'_c}) bd^2 = 4.33d^2 = (4.33)(12.5)^2 = 676^{''k} > 397^{''k}$ ok

Use 24" wall - Exterior Wall Inlet Chamber (need weight)

NRH 12/31/90

✓ GRS 1/91

Pump Station

Determine Wall thickness - Interior walls

Wall between Sump area and Forebay

Span 5' betw. walls up to El. 706.5. Hydrostatic head on one side.

By inspection a 16" wall is sufficient. Need 16" to support 16" wall above.

Determine wall thickness of walls between pump chambers up to El. 706.5.

$p = (62.5)(13.5') = 844$ psf

Use Monograph of Tables used for rectangular plates + slabs - Moment + shear coeff.

$a/b = \frac{15/2}{13.5} = .56$, Reactions - worst case : R_y @ $x/a = 1.0$

figure 4: $R_y = .3434$ △

Max. shear = (.3434)(.844)(13.5) = 3.9^k min. 14", d = 10.5"

V_u @ d out = 3.9 - [.789 + (½)(.055)]($\frac{10.5}{12}$) = 3.9 - .71 = 3.2^k × 1.7 = 5.4^k

$\phi V_c = 1.29(d) = (1.29)(10.5) = 13.5^k > 5.4^k$ ok 14" wall

Moment worst case: M_y @ $x/a = 1.0$, $y/b = 0$

figure 4: $M_y = .0387$ △

Max Mom. = (.0387)(.844)(13.5)^2 = 6.0$'^k$ = 71.5$''^k$

$M_u = 1.7 \times 1.3 \times 71.5 = 158''^k$

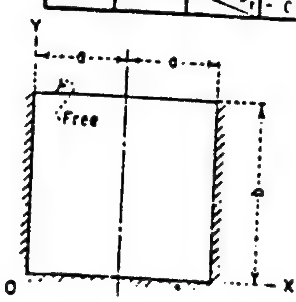
$\rho_{max} = .25\rho_b = .00726$ 14" wall d = 10.5

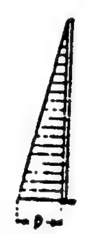
$\phi M_n = 4.33d^2 = (4.33)(10.5)^2 = 477''^k > 158''^k$ ok

Use 14" wall betwee pump chambers.

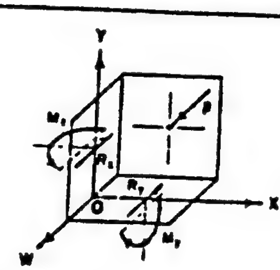
MOMENTS AND REACTIONS FOR RECTANGULAR PLATES

a/b	y/b	R_x \ x/a	M_x 0	M_x 0.2	M_x 0.4	M_x 0.6	M_x 0.8	M_x 1.0	M_y 0	M_y 0.2	M_y 0.4	M_y 0.6	M_y 0.8	M_y 1.0
a/b = 1/8	1.0	+.0062	+.0004	+.0002	+.0000	-.0001	-.0002	-.0002	0	0	0	0	0	0
	0.8	+.0251	+.0011	+.0005	+.0000	-.0003	-.0005	-.0005	+.0002	+.0001	+.0000	-.0000	-.0001	-.0001
	0.6	+.0496	+.0021	+.0009	+.0001	-.0006	-.0009	-.0011	+.0004	+.0002	+.0000	-.0001	-.0002	-.0002
	0.4	+.0751	+.0031	+.0014	+.0001	-.0008	-.0014	-.0016	+.0006	+.0003	+.0000	-.0002	-.0003	-.0003
	0.2	+.0942	+.0038	+.0016	+.0000	-.0010	-.0017	-.0019	+.0008	+.0003	-.0000	-.0003	-.0005	-.0005
	0	+.0460	0	+.0001	+.0003	+.0005	+.0006	+.0006	0	+.0005	+.0014	+.0023	+.0028	+.0030
		R_x \ R_y	+.0460	+.0136	+.0543	+.0839	+.1004	+.1056						
a/b = 1/4	1.0	+.0147	+.0022	+.0012	+.0002	-.0006	-.0012	-.0014	0	0	0	0	0	0
	0.8	+.0523	+.0046	+.0022	+.0002	-.0012	-.0021	-.0024	+.0009	+.0005	+.0002	-.0000	-.0002	-.0002
	0.6	+.1015	+.0083	+.0037	+.0002	-.0023	-.0038	-.0042	+.0017	+.0007	-.0000	-.0005	-.0009	-.0010
	0.4	+.1514	+.0114	+.0049	+.0001	-.0032	-.0051	-.0057	+.0023	+.0008	-.0004	-.0013	-.0019	-.0021
	0.2	+.1494	+.0102	+.0037	-.0004	-.0030	-.0043	-.0047	+.0020	+.0004	-.0011	-.0022	-.0029	-.0031
	0	+.0304	0	+.0004	+.0010	+.0016	+.0020	+.0021	0	+.0020	+.0052	+.0081	+.0100	+.0107
		R_x \ R_y	+.0304	+.0309	+.1052	+.1563	+.1856	+.1950						
a/b = 3/8	1.0	+.0189	+.0056	+.0040	+.0008	-.0020	-.0039	-.0045	0	0	0	0	0	0
	0.8	+.0885	+.0117	+.0055	+.0006	-.0031	-.0054	-.0062	+.0023	+.0012	+.0004	-.0002	-.0005	-.0007
	0.6	+.1541	+.0176	+.0075	+.0001	-.0049	-.0079	-.0088	+.0035	+.0013	-.0006	-.0020	-.0029	-.0032
	0.4	+.2107	+.0208	+.0079	-.0007	-.0061	-.0090	-.0099	+.0042	+.0009	-.0019	-.0042	-.0056	-.0061
	0.2	+.1631	+.0145	+.0045	-.0012	-.0042	-.0057	-.0061	+.0029	+.0001	-.0022	-.0039	-.0048	-.0051
	0	+.0102	0	+.0009	+.0020	+.0030	+.0035	+.0040	0	+.0039	+.0099	+.0152	+.0188	+.0200
		R_x \ R_y	+.0102	+.0474	+.1669	+.2154	+.2526	+.2645						
a/b = 1/2	1.0	+.0326	+.0151	+.0088	+.0015	-.0046	-.0084	-.0097	0	0	0	0	0	0
	0.8	+.1315	+.0216	+.0099	+.0007	-.0059	-.0099	-.0112	+.0043	+.0020	+.0002	-.0011	-.0019	-.0022
	0.6	+.1972	+.0273	+.0105	-.0005	-.0079	-.0119	-.0132	+.0055	+.0015	-.0020	-.0047	-.0064	-.0070
	0.4	+.2421	+.0277	+.0092	-.0019	-.0082	-.0115	-.0125	+.0055	+.0004	-.0042	-.0076	-.0097	-.0104
	0.2	+.1607	+.0160	+.0041	-.0017	-.0044	-.0055	-.0058	+.0032	-.0002	-.0026	-.0039	-.0044	-.0046
	0	-.0045	0	+.0014	+.0033	+.0050	+.0061	+.0065	0	+.0068	+.0167	+.0252	+.0307	+.0325
		R_x \ R_y	-.0045	+.0744	+.1932	+.2659	+.3108	+.3236						
a/b = 3/4	1.0	+.1061	+.0405	+.0196	+.0013	-.0115	-.0190	-.0214	0	0	0	0	0	0
	0.8	+.2077	+.0433	+.0177	-.0003	-.0119	-.0184	-.0205	+.0097	+.0031	-.0012	-.0042	-.0061	-.0067
	0.6	+.2406	+.0426	+.0145	-.0026	-.0124	-.0174	-.0199	+.0085	+.0010	-.0055	-.0102	-.0130	-.0139
	0.4	+.2542	+.0349	+.0091	-.0039	-.0102	-.0130	-.0138	+.0070	-.0011	-.0075	-.0115	-.0137	-.0143
	0.2	+.1337	+.0163	+.0031	-.0017	-.0031	-.0033	-.0033	+.0033	+.0001	-.0000	+.0014	+.0029	+.0035
	0	-.0195	0	+.0028	+.0064	+.0093	+.0111	+.0117	0	+.0139	+.0320	+.0465	+.0554	+.0584
		R_x \ R_y	-.0196	+.1256	+.2566	+.3496	+.3923	+.4055						
a/b = 1	1.0	+.1585	+.0544	+.0253	-.0013	-.0172	-.0252	-.0276	0	0	0	0	0	0
	0.8	+.2564	+.0601	+.0210	-.0028	-.0161	-.0226	-.0245	+.0120	+.0034	-.0026	-.0065	-.0083	-.0095
	0.6	+.2455	+.0515	+.0149	-.0047	-.0145	-.0189	-.0201	+.0103	+.0003	-.0075	-.0125	-.0151	-.0159
	0.4	+.2411	+.0372	+.0078	-.0049	-.0100	-.0118	-.0122	+.0074	-.0021	-.0076	-.0099	-.0106	-.0107
	0.2	+.1108	+.0154	+.0025	-.0006	-.0006	-.0000	-.0003	+.0031	+.0018	+.0060	+.0116	+.0160	+.0175
	0	-.0241	0	+.0044	+.0096	+.0137	+.0161	+.0169	0	+.0220	+.0442	+.0683	+.0804	+.0845
		R_x \ R_y	-.0241	+.1691	+.3193	+.4038	+.4457	+.4594						
a/b = 3/2	1.0	+.3127	+.0857	+.0207	-.0087	-.0199	-.0232	-.0233	0	0	0	0	0	0
	0.8	+.2929	+.0730	+.0158	-.0086	-.0172	-.0194	-.0198	+.0146	+.0023	-.0042	-.0072	-.0082	-.0085
	0.6	+.2352	+.0560	+.0054	-.0083	-.0134	-.0142	-.0141	+.0112	-.0013	-.0077	-.0096	-.0096	-.0094
	0.4	+.2148	+.0359	+.0038	-.0053	-.0055	-.0057	-.0053	+.0072	-.0021	-.0023	-.0012	+.0046	+.0059
	0.2	+.0837	+.0132	+.0021	+.0025	+.0050	+.0069	+.0076	+.0026	+.0077	+.0220	+.0356	+.0444	+.0476
	0	-.0204	0	+.0079	+.0159	+.0212	+.0243	+.0252	0	+.0396	+.0791	+.1062	+.1214	+.1252
		R_x \ R_y	-.0204	+.2452	+.3564	+.4669	+.4966	+.5047						





Moment = (Coefficient)(pb^2)
Reaction = (Coefficient)(pb)



POSITIVE SIGN CONVENTION

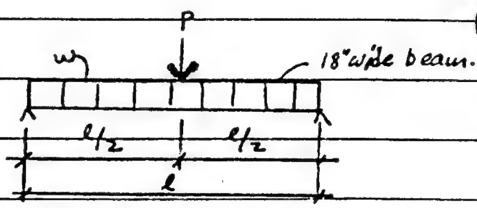
FIGURE 4.—*Plate fixed along three edges, moment and reaction coefficients, Load IV, uniformly varying load.*

ARH 12/31/90
✓GRS 1/91

Pump Station
Determine thickness of floor slab at El. 714.75
EM 1110-2-3104
Operating Floor: Live Load 100 psf plus floor must be designed to allow placement of the heaviest piece of machinery anywhere on the floor. Heaviest piece of equipment will be a pump. Weight of pump 3000 lbs.

Walls were designed for a hinged connection at top slab (operating floor). The walls are quite long, so will have reduced fixity. Top of walls may have reduced thickness because of brick ledge. Therefore assume slab hinged at wall.

M = Design Moment = $\frac{wl^2}{8} + \frac{Pl}{4}$



$l = 15'$

$w = 100\,psf\,(5' + 1.5') = .65\ ^k/FT.$

$P = 3000^k$

$M = (\frac{1}{8})(.65)(15)^2 + (\frac{1}{4})(3)(15) = 18.3 + 11.3 = 29.5'^k = 355\ ''^k$

$M_u = 1.7 \times 1.3 \times 355 = 783\ ''^k$ Hydraulic Structure

$\phi M_n = \phi \rho f_y \left(1 - \frac{\rho f_y}{1.7 f'_c}\right) b d^2$ Strength Design Manual

$f'_c = 4000\,psi$, $f_y = 60000\,psi$, $\phi = .9$, $b = 18"$ $\rho_{max} = .25\rho_b = .007126$

$\phi M_n = (.9)(.007126)(60)\left[1 - \frac{(.007126)(60)}{(1.7)(4)}\right](b)(d)^2 = .36(18)\,d^2$; $d_{min} = \sqrt{\frac{783}{6.48}} = 11.0" + 3.5 = 14.5" \sim 15"$ slab

$\phi M_n = 6.49(11.5)^2 = 858\ ''^k > 783\ ''^k$ (ok) → use 15" thick slab on operating floor El. 714.75

Max. shear (move load P to end) $= \frac{wl}{2} + P = (.65)(7.5) + 3 = 7.88^k$

$V_u = 1.7 \times 1.3 \times 7.88 = 17.4^k$ @ support

$\phi V_c = \phi .126\,bd = .85(.126)(18)(11.5) = 22.2^k > 17.4$ (ok)

NRH 1/3/91

✓GRS 1/91

Pump Station

Foreway Slab El. 710

There is a wall around the Forebay top slab so vehicles cannot be on this slab.

The heaviest equipment on this floor will be a sluice gate.

weight of sluice gate approx. 3000#.

the size of the forebay area is the same (or very similar) to the sump area.

therefore the design will be the same as the sump area top slab El. 714.75.

Use 14" slab.

Check slab for gate operator

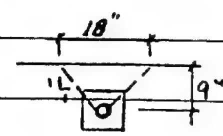
Based on manufacturer catalogs for 48x48 gate

Operator lifting force = 8000# F.S.=5 (EM 1110-2-3104) F = 8000x5 = 40k

distance ℄ stem to wall = 9"

Moment = 40k x 9" = 360 "k , Mu = 1.7x1.3x360"k = 796 "k

Shear = 40k , Vu = 1.7x1.3x40k = 88k



$\phi M_n = .36\,bd^2$ (d = 14 - 2.5 = 11.5") = (.36)(18)(11.5)² = 857 "k > 796 "k 15" slab ok

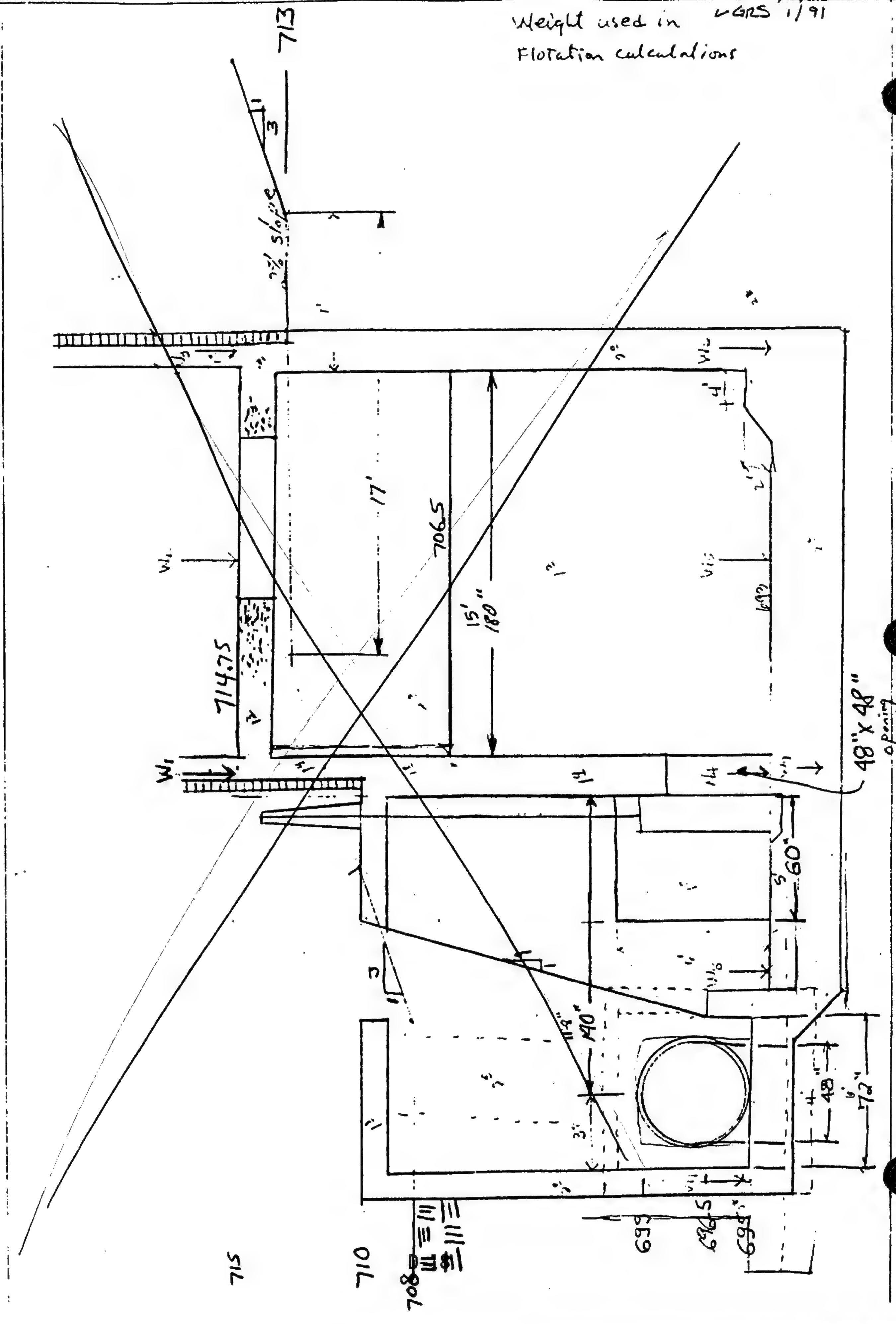
Shear-friction

ACI 11.7.5 $\phi V_c = \phi .2 f'_c bd = \phi .8 bd$ = (.68)(18)(11.5) = 140k > 88k (ok)

$A_{vf} = \frac{V_u}{\phi f_y \mu}$ = (88)/((.85)(60)(1.4)) = 1.23 in² / 18" width 15" slab (ok)

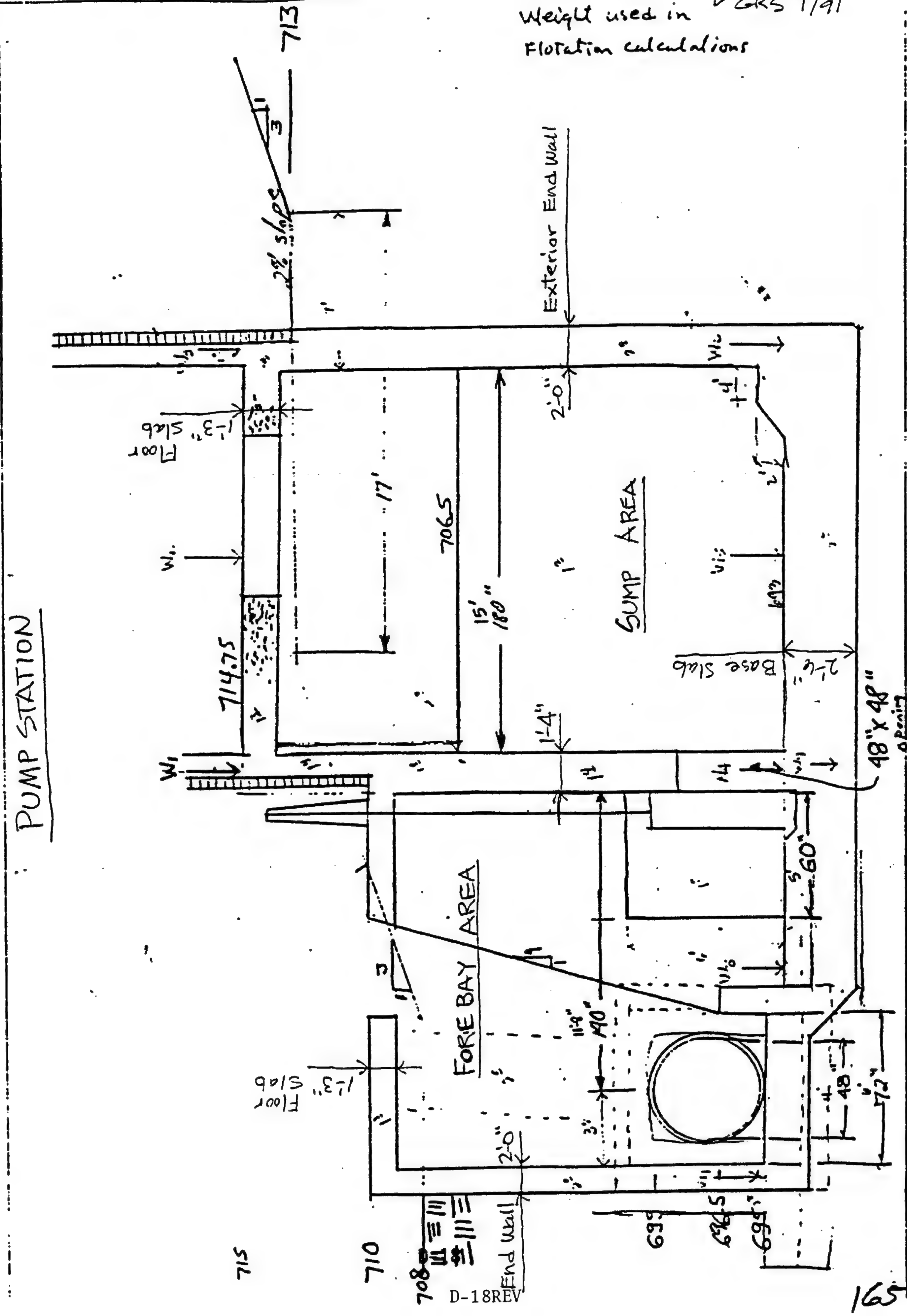
page 11
NRH 1/3/91
✓GRS 1/91

Weight used in
Flotation calculations



page 11
NRH 1/3/91
✓ GRS 1/91

Weight used in Flotation calculations



NRH 1/3/91

✓GRS 1/91

Pumping Station

Weigt (dead load) uses for flotation calculations -

Concrete:

$W_1 = W_3$: Roof + walls superstructure

Roof dead load (assume 5psf): $(5)(\frac{18'}{2})(27.33')$ = 1.23

12" conc. wall: $(150pcf)(1')(12')(27.33')$ = 49.19

4" brick wall: $(40psf)(12')(27.33')$ = 13.12

$W_1 = W_3$ = 63.54^k

W_2: walls - superstructure

12" conc. wall: $(150pcf)[(1')(12')(15.33')^{(2)} - (door)(1')(10')(6')]$ = 46.19

4" brick wall: $(40pcf)[(12')(15.33)^{(2)} - (door)(10')(6')]$ = 12.32

W_2 = 58.50^k

W_4: conc. walls substructure

4" Brick: $(40psf)(4.75')(27.33')$ = 5.19

16" conc. wall: $(150pcf)(1.33')[(4.75')(22') + (9.75')(5.33')]$ = 31.22

20" conc. wall: $(150pcf)(1.67')(3.5')(22')$ = 19.29

16" wall: $(150)(1.33)[(13.5')(22') - (4')(4')(3)]$ = 49.68

W_4 = 105.38

W_5: 2 exterior walls + 2 interior walls + 7/4.75 slab + 1 grade beam - Substructure

24" walls: $(150pcf)(2')(15')(21.75')(2)$ = 195.75

14" walls: $(150pcf)(1.17')(15')(13.50')(2)$ = 71.08

15" slab: $(150pcf)(1.25')[(15')(18+4') - (5')(6')(3) - (2.5')(2.5')]$ = 43.83

16" grade beam: $(150pcf)(1.33')(15')(5')$ = 14.96

W_5 = 325.62

NRH 1/4/91

✓GRS 1/91

Pumping Station
Weight (con't)

W6: exterior wall + grade beam - substructure

24" wall: (150pcf) (2') (22') (21.75') = 143.55

16" grade beam: (150pcf) (1.33) (5') (5.33') = 5.32

W6 = 148.87 k

W7: exterior wall - substructure + brick wall - superstructure

24" wall: (150pcf) (2') (22') (15') = 99.00

4" brick wall: (40psf) (3') (22') = 2.64

W7 = 101.64 k

W8: 2 exterior walls + 2 small interior walls + 710 slab - substructure + brick wall - superstructure

24" walls: (150pcf) (2') [(6')(15') + (9.67')(17')] (2) = 142.43

12" walls: (150pcf) (1') [(6')(5')(2) + (1.5')(18')] = 13.05

15" slab: (150pcf) (1.25') [(14.67')(18') - (3')(5')(3)] = 41.07

4" brick wall: (40psf) (3') (16.67 + 10') = 3.20

W8 = 199.75 k

W9: Base Slab - Substructure

36" slab: (150pcf) (3') (22') (35') W9 = 346.5

NRH 1/4/91
✓ GRS 1/91

Pumping Station
Weight for Flotation (con't)

W_E - Wt. of Fixed Equipment

48"x48" sluicegate	2100# x 3	= 6,300
pump	3000# x 3	= 9,000
motor control center (Electrical)	1 unit	= 6,000
	W_E	= 21.3^k

W_W - wt. of water to El. 698 (lowest pump operating range) in Forebay.

$(18')(.0625 \text{ kcf})[(7')(3') + (7.67')(5')]$ $W_W = 66.77^k$

TOTAL Dead Load weight = 1501.41^k

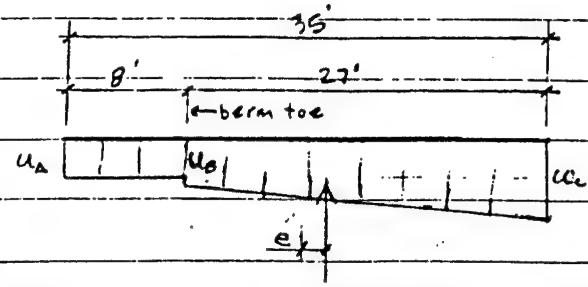
Pumping Station

UPLIFT EM 1110-2-3104

uplift head at berm toe = El 713

uplift head toward river =

El 713 + $\frac{16'}{150'}$ (27') = El 716



$U_A = (713' - 692')(22')(.0625\ kcf) = 28.88^k/FT.$

$U = 1140.67^k$ (1.48 ksf) Avg.

$U_B = (713 - 690)(22')(.0625\ kcf) = 31.63^k/FT.$

$U_C = (716 - 690)(22')(.0625\ kcf) = 35.75^k/FT$

		distance to center	Mom. abt. center
$U_A = 28.88(35') =$	1010.8^k	0	0
$U_B = (31.63 - 28.88)(27') =$	74.25^k	4'	$297^{'k}$
$U_C = (35.75 - 31.63)(27'/2) =$	55.62^k	8.5'	$472.77^{'k}$
	1140.67^k		$769.77^{'k}$

$e = 769.77^{'k} / 1140.67^k = .67'$ from center – basically in center of slab area

F.S. = $W_s + W_c / U - W_q$ EM 1110-2-3104 Appendix B

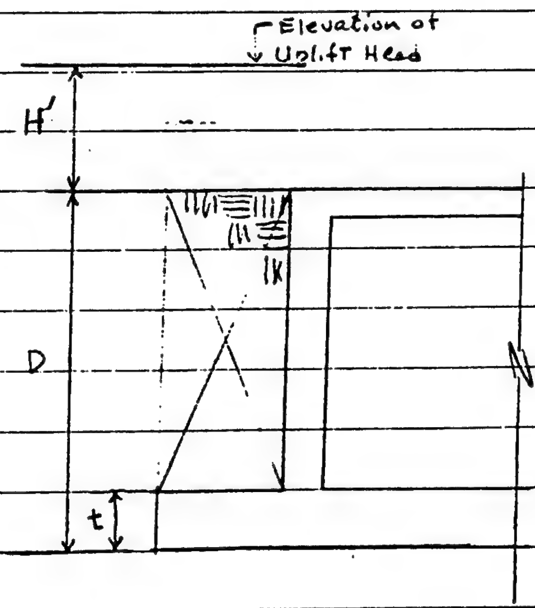
F.S. (flotation) = $1501.41^k / 1140.67^k = 1.32 < 1.5$ req's slab extensions or thicker base slab.

Slab extensions:

$U - W_q = \gamma_w t = 62.5\,t$

$W_s = \gamma_{conc.} t + [(\gamma_{sat.} - \gamma_w)(D - t) - (\gamma_w H')]$

multiply $(U - W_q)$ and W_s times the same area.



Pumping Station
Base Slab - Determine thickness

Assume rectangular soil pressure on base slab equal to total load (dead load + live load) divided by area of slab.
Total load is worst load on base slab during uplift or no uplift.

Live Load EM 1110-2-3104

Roof: (50 psf) (27.33') (18.33')	=	25.05
Floor El. 714.75 (100 psf) (27.33)(18.33)	=	50.10
Floor El. 710 (100 psf)(22')(16.67')	=	36.67
Floor El 693 (100 psf) (18')(31')	=	55.80
Floors misc items trashrack, catwalk, ladders, equip etc (100 psf) (18')(31')	=	55.80
Total Liveload	=	223.42^k

Soil load on 2' base slab extensions (previous sheet dead load):

$(2')(115)\{(708-695)[22'+11'(2)]+[(713-693)(26')]+[(708-693)+(713-693)](\tfrac{1}{2})(26')(2)\}$ = 460.46^k

Conc. slab extensions:

$(150pcf)(3')(2')[22'(2)+39'(2)]$ = 109.80^k

TOTAL DEAD LOAD = 1501.41^k

TOTAL LOAD = 2295.09^k

Soil Pressure = 2295.09/(26')(39') = 2.26 ksf

Pumping Station

Flotation · 3' thick slab 3' slab extensions Preliminary

$U\text{-}W_q = (.0625\,kcf)(3')(3')[(22')(2) + (41')(2)] = 70.88^k \uparrow$

$W_s = (.150\,kcf)(3')(3')[(22')(2) + (41')(2)]$ concrete $= 170.10$

$W_s = [(.120-.0625)(708'-695') - (.0625)(713'-708')](3')[22' + 42')(2)]$ 60.03

$+[(.120-.0625)(713'-693') - (.0625)(716-713)](3')(28')$ 80.15

$+[(.120-.0625)(708-693) - (.0625)(713-708)] + [(.120-.0625)(713-693) - (.0625)(716-713)]$

$(\frac{1}{2})(3')(29')(2)$ 131.59 soil $= 272.47$

$W_s = 442.57^k \downarrow$

F.S. = 1501.41 + 442.57 / 1140.67 + 70.88 = 1.60

Flotation · 3' thick slab + 2' slab extensions Preliminary

$U\text{-}W_q = (.0625\,kcf)(3')(2')[(22')(2) + (39')(2)] = 45.75^k \uparrow$

$W_s = (.150\,kcf)(3')(2')[(22')(2) + (39')(2)]$ concrete $= 109.80$

$W_s = [(.120-.0625)(708-695) - (.0625)(713-708)](2')[22' + 41')(2)]$ 38.28

$+[(.120-.0625)(713-693) - (.0625)(716-713)](2')(26')$ 50.05

$+(.120-.0625)(708-693) - (.0625)(713-708) + [(.120-.0625)(713-693) - (.0625)(716-713)]$

$(\frac{1}{2})(2')(26')(2)$ 78.65 soil $= 166.98$

$W_s = 276.78$

F.S. = 1501.41 + 276.78 / 1140.67 + 45.75 = 1.50 ~ 1.50 (ok)

NRH 1/4/91

✓GRS 1/91

Pumping Station

Flotation with 2'-6" Base Slab

.5 less uplift head

$1140.67^k - (.5')(.0625)(22')(35') = 1116.61^k$

2.5' thick Base Slab

$1501.41 - (.5)(.150)(22)(35') = 1443.66^k$

Try 2'-3" base slab extensions

$U - W_q = (.0625\ kcf)(2.5')(2.25)[(22.5 + 39.5)(2)] = 43.59^k \uparrow$

$W_s(\text{concrete}) = (.150\ kcf)(2.5')(2.25)[(22.5 + 39.5)(2)] = 104.63$

W_s (soil) (see previous sheet) $43.55 + 57.39 + 88.48 = 189.42$

$294.05^k \downarrow$

$F.S. = 1443.66 + 294.05 / 1116.61 + 43.59 = 1.50$ (OK) FLOTATION Pump Station per EM 1110-2-3104

Volume of concrete in slab	Reinforcement of slab	COST
2'-6" slab = 2589 C.F. @ $180/c.y.	1.6 in²/FT $.20/#	$22,893
3'-0" slab = 3042 C.F. @ $180/c.y.	1.2 in²/FT $.20/#	$24,417

→ USE 2'-6" Base Slab w/ 2'-3" extensions out from wall

Pumping Station
Base Slab (con't)

Span 18' wall to wall. Moment at wall will be whatever moment is from wall. therefore assume little fixity from walls. Use hinge at wall or design base slab as simple supports btw. walls.

$W = 2.29 K/FT - (\text{slab wt.})(.15)(3') = 2.29 - .45 = 1.84 K/FT.$

$M = \frac{1}{8} w l^2 = (\frac{1}{8})(1.84)(18)^2 = 74.7^{'k} = 896^{''k}$

$M_u = 1.7 \times 1.3 \times 896 = 1980^{''k}$

$d = 36 - 3.5 = 33.5$

$\phi M_n = .36\, bd^2 = (.36)(12)(33.5)^2 = 4848^{''k} > 1980^{''k}$ (ok)

$\phi M_n = \phi f_y A_s (d - \frac{A_s f_y}{1.7 b f'_c}) = 54 A_s (d - .74 A_s) = 2113^{''k}$ for $A_s = 1.2\, IN^2/FT$

Try 2'-6" thick Base Slab

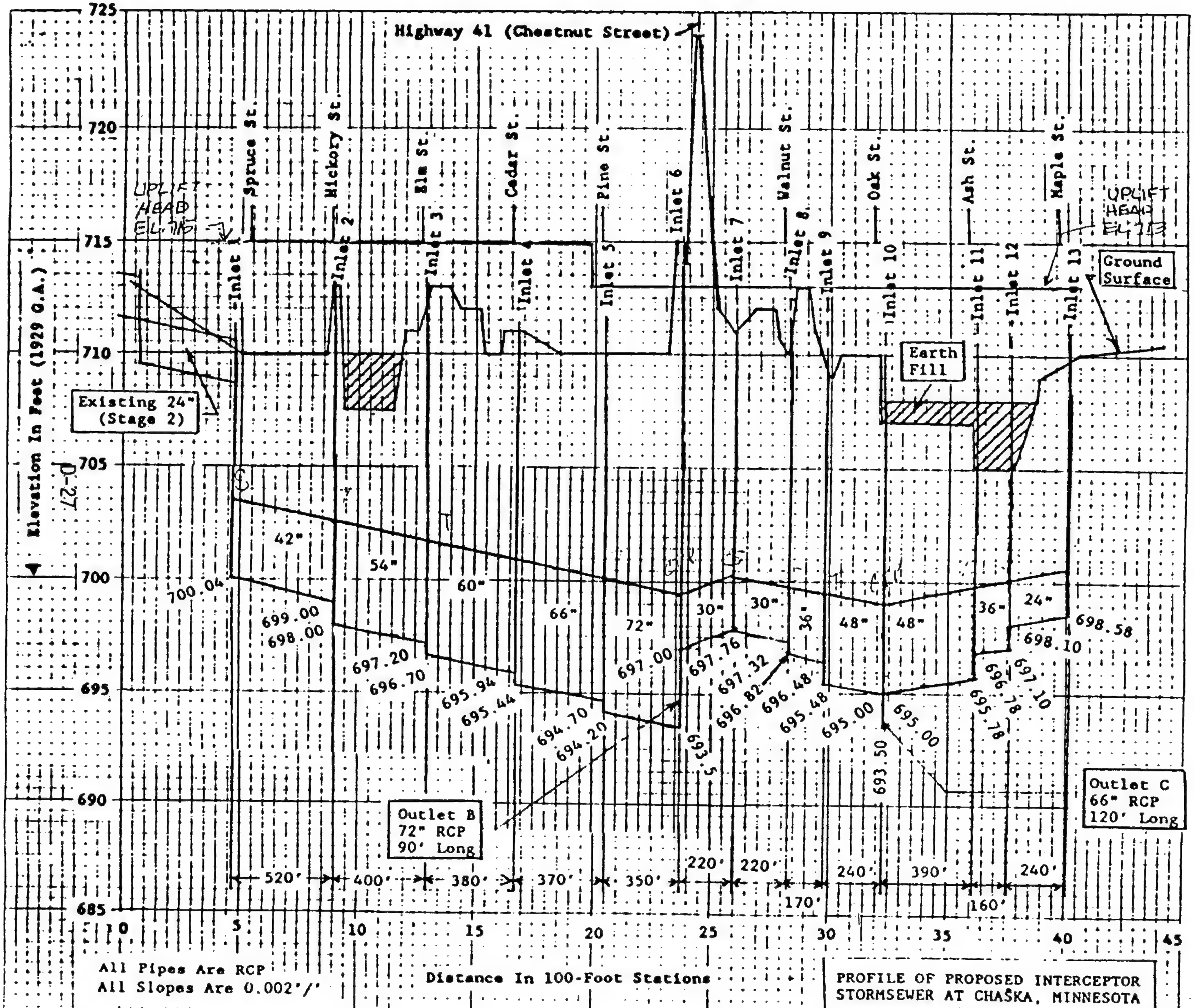
$d = 30" - 3.5" = 26.5"$

$\phi M_n = .36\, bd^2 = (.36)(12)(26.5)^2 = 3033^{''k} > 1980^{''k}$ (ok)

Max $A_s = .007126\, bh = (.007126)(12)(30) = 2.57\, IN^2/FT.$

$\phi M_n = 54 A_s (d - .74 A_s) = 2187^{''k}$ for $A_s = 1.6\, IN^2/FT.$

K•E 10 X 10 TO THE INCH • 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A. 46 0700



PROFILE OF PROPOSED INTERCEPTOR STORMSEWER AT CHAŠKA, MINNESOTA PLAN D

D-27

Relief wells use 5-13

page 20

File ...

Rcd
12/7/70

page 21

TABLE A-20

REQUIRED SIZE OF GRATED INLETS AND CONNECTING FEEDER PIPE

REQUIRED SIZE OF GRATES — REQUIRED SIZE AND LEVEL OF FEEDER PIPES

Inlet No.	Contrib. Wat'shed Location	Design Q 1%	Design Q SPS	Approx. Rim Elev.	Max. Allow. Pond Level (SPS)	Max. Allow. Head (Ft.) (1)	Based On A Single Inlet (6): Reqd. Perm. (Ft.) (3)	Based On A Single Inlet (6): Reqd. Area (A) (SqFt.) (4)	Based On A Single Inlet (6): Recommended Area 2A (SqFt.) (5)	Available Head In Feet (7)	Based on One Inlet: Required RCP Pipe Size (Inches) (8)	Based on One Inlet: HW	Based on One Inlet: Max. Allow. Inlet Invert Elev. (9)	Based on Two Inlets: Required RCP Pipe Size (Inches) (8)	Based on Two Inlets: HW	Based on Two Inlets: Max. Allow. Inlet Invert Elev. (9)
1	2a	37	57	~~708~~ 710	710.9	2.9	3.8 12.3	7.0 12.5	13.9 25.0	0.11	-	-	-	48	2.4	708.5
2	2b	24	36	710	710.9	0.9	14.1	7.9	15.8	2.70	30	3.9	707.0	24	2.7	708.2
3	2c	23	34	710	710.9	0.9	13.3	7.4	14.9	4.38	24	6.0	704.9	24	2.6	708.3
4	2d	31	45	710	710.9	0.9	17.6	9.9	19.7	6.21	24	9.4	701.5	24	3.4	707.5
5	2e	27	40	710	710.9	0.9	15.6	8.8	17.5	8.31	24	7.6	703.3	24	3.0	707.9
6	2f	20	28	714	710.9	(2) 1.0	9.3	5.8	11.6	10.38	24	3.5	707.4	24	2.2	708.7
7	3a	29	42	711	712.5	1.5	7.6	7.1	14.2	1.72	36	3.5	709.0	24	3.2	709.3
8	3b	14	17	710	712.5	2.5	1.4	2.2	4.5	5.76	24	2.6	709.9	-	-	-
9	3c	17	31	709	712.5	3.5	1.6	3.4	6.9	8.60	24	5.3	707.2	24	2.3	710.2
10	3d	51	65	708	712.5	4.5	2.3	6.4	12.7	10.65	36	5.6	706.9	24	5.6	706.9
11	3e	34	47	708	712.5	4.5	1.6	4.6	9.2	7.34	24	9.8	702.7	24	3.6	708.9
12	3f	16	27	708	712.5	4.5	0.9	2.6	5.3	5.20	24	4.3	708.2	-	-	-
13	3g	21	25	709	712.5	3.5	1.3	2.8	5.6	0.62	36	2.4	710.1	-	-	-
											2-24"φ			24	2.0	710.5

(1) Allowable pond level, less rim elevation.
(2) Ground level in area will permit this condition.
(3) Q = 3*L*H^1.5, L = Q/(3*H^1.5)
(4) Q = 0.6*A*(2*G*H)^0.5, A = Q/((0.6*(2*G*H)^0.5)
(5) Assumes grate is 50 percent obstructed.
(6) With two inlets, the indicated requirements can be reduced 50 percent.
(7) Maximum allowable pond level (SPS), less resulting hyd gradiant for SPS from Table A-18.
(8) Assumes a pipe length of 20 feet.
(9) Maximum allowable pond level, less HW.

Use grates ... on ...
R-1792 ...

Chaska Stage 4 FDM — Inlets — Preliminary — NRH 11-20-90
GRS 1/91

Largest Req'd. Inlet Area is Inlet "4" @ 9.9 sq. ft.

Determine inlet size with req'd area.

Try Neenah R-3246-AL Curb Inlet Frame, Grate, Curb Box (Cast Iron)

FOR TYPE L GRATE, FREE OPEN AREA = 3.0 SQ. FT. PER UNIT

multiple inlets are made from basic pattern with base flanges at butting sides eliminated.

Assume 1 inlet each side of street.

REF: TM 5-820-4/AFM 88-5, Chap. 4 3-10

For a combination inlet: In estimating capacity, the inlet will be treated as a simple grated inlet, but a safety factor of 25 to 75 percent will be applied. For a grated inlet use a safety factor of 100%.

∴ Area req'd for inlet = 1.75 × 9.9 sq ft = 17.3 sq. ft.

2 inlets with 3 units each = 2 × 3 × 3.0 = 18.0 sq. ft. Area provided (F.S. = 1.82)

	Area Provided (sq. ft.) Gross opening 30" x 36"	Area (sq. ft.) A/1.75	Inlet No.
Combination curb-grate inlet			
2 inlets – 3 units each	18.0	10.3	1, 2, 3, 4, 5, 7
2 inlets – 2 units ea.	12.0	6.8	6, 10, 11
2 inlets – 1 unit ea.	6.0	3.4	8, 9, 12, 13

	Gross opening 30" x 36"	A/2.0	
Grated inlet			
2 inlets – 3 units + 4 units	21.0	10.5	4
2 inlets – 3 units ea.	18.0	9.0	1, 2, 3, 5, 7, 10
2 inlets – 2 units ea.	12.0	6.0	6, 9, 11
2 inlets – 1 unit ea.	6.0	3.0	8, 12, 13

→ Will not use curb inlets

Chaska Stage 4 FDM — NRH 11-26-90

Inlets — GRS 1/91

· Determine inlet size with req'd. area.

Try Neenah R-4990 or R-4999 Heavy Duty Transverse Drainage Struct.

TYPE A GRATE (use because less wt. than type C with about same open sq. ft.)

R-4990-MX TYPE A (36" wide) = 1.3 sq. ft. open/L.F. ; R-4990-OX TYPE A (48" wide) = 1.7 sq. ft. open/

48" wide - 1.7 sq. ft/L.F.	Area Provided (sq. ft.)	Req'd Area sq. ft A/2.0 (F.S.)	Inlet No.
12' long	20.4	10.2	4, 5
10' long	17.0	8.5	2, 3, 7
8' long	13.6	6.8	6, 10
6' long	10.2	5.1	11
4'×4' R-[illegible]-A 7.04 ft — 4' long	6.8	3.4	8, 9, 12, 13
16' long	27.2	13.5	1
36" wide - 1.3 sq. ft/L.F.			
→ 16' long	20.8	10.4	4
14' long	18.2	9.1	2, 5
→ 12' long	15.6	7.8	1, 3, 7
10' long	13.0	6.5	6, 10
8' long	10.4	5.2	11
→ 6' long	7.8	3.9	8, 9, 12, 13

WT. 48" wide : (2×12') + (4×10') + (2×8') + (1×6') + (4×4') = 102 L.F × (190+17) #/L.F. = 21,114 #

WT. 36" wide : (1×16') + (2×14') + (3×12') + (2×10') + (1×8') + (4×6') = 132 L.F. × (130+17) #/L.F. = 19,404 #

Double inlets 48" wide : (12×6') + (10×4') = 112 L.F. × 207 #/L.F. = 23,184 #

Double inlets 36" wide : (6×8') + (14×6') + (2×4') = 140 L.F. × 147 #/L.F. = 20,580 #

Neenah type cast iron grates were used because they are commonly used in the industry for municipal storm drain systems. They are corrosion resistant, strong enough for vehicle traffic, and heavy enough so they

NRH 12/5/90

✓ GRS 1/91

Inlets

Determine least costly ~~street~~ inlets

Assume inlets 5' deep - 10" thick walls - 12" thick base

48" wide inlet - double inlets

6' long - 12 (1'×6'×4') + (.83'×5'×(6'+4')(2)) = 1288

4' long - 10 (1'×4'×4') + (.83'×5'×(4'+4')(2)) = 827

2115 c.f. = 78.3 c.y.

36" wide inlet - double inlets

8' long - 6 (1'×8'×3') + (.83'×5'×(8'+3')(2)) = 492

6' long - 14 (1'×6'×3') + (.83'×5'×(6'+3')(2)) = 1298

4' long - 2 (1'×4'×3') + (.83'×5'×(4'+3')(2)) = 140

2130 c.f. = 78.9 c.y.

48" wide inlet - single inlets

12' long - 2 (1×12×4) + (.83×5'×(12+4)(2)) = 362

10' long - 4 (1×10×4) + (.83×5×(10+4)(2)) = 625

8' long - 2 (1×8×4) + (.83×5×(8+4)(2)) = 263

6' long - 1 (1×6×4) + (.83×5×(6+4)(2)) = 107

4' long - 4 (1×4×4) + (.83×5×(4+4)(2)) = 330

1686 c.f. = 62.5 c.y.

36" wide inlet - single inlet

16' long - 1 (1×16×3) + (.83×5'×(16+3)(2)) = 206

14' long - 2 (1×14×3) + (.83×5'×(14+3)(2)) = 366

12' long - 3 (1×12×3) + (.83×5'×(12+3)(2)) = 482

10' long - 2 (1×10×3) + (.83×5'×(10+3)(2)) = 276

8' long - 1 (1×8×3) + (.83×5'×(8+3)(2)) = 115

6' long - 4 (1×6×3) + (.83×5'×(6+3)(2)) = 371

1815 c.f. = 67.2 c.y.

NRII 12/5/90

✓ GRS 1/91

Inlets

Cost comparison between 48" + 36" wide inlets

single inlets

48" wide:

casting: 102 L.F. × $119/L.F. = 12,138

concrete: 62.5 C.Y. × $250/C.Y. = 15,625

$27,763 ← $2105 less

36" wide:

casting: 132 L.F. × $99/L.F. = 13,068

concrete: 67.2 C.Y. × $250/C.Y. = 16,800

$29,868

double inlets

48" wide –

casting: 112 L.F. × $119/L.F. = 13,328

concrete: 78.3 C.Y. × $250/C.Y. = 19,575

$32,903 ← $682 less

36" wide –

casting: 140 L.F. × $99/L.F. = 13,860

concrete: 78.9 L.F. × $250/C.Y. = 19,725

$33,585

For single or large inlets, based on the above analysis – use 48" wide.

For double or smaller inlets, based on the small savings – either (36" or 48") could be used.

Claska Stage 4 FDM. NRH 12-5-90

Inlets ✓ GRS 1/91

Refer to Memo from Hydraulics 10 sept. 90 Table A-20.

J. Megge gave me pipe sizes from inlets to M.H. (guess)

If feeder pipes are greater than 24" Dia. the risers coming up from the interceptor must be greater than 48" Dia. Because the interceptor is so deep, it is assummed the risers will be no greater than 48" due to more cost of larger riser pipe.

Therefore any pipe between the inlet and M.H. must be 24" dia or less

So if a pipe size greater than 2-" is required, then use 2 inets so pipe is less than 24".

NKH 12/28/90

✓ GRS 1/91

Floatation of Inlets

Inlet or M.H. No.	Uplift Head Elevation	Inlet Rim Elevation
1	715	710
2	715	710
3	715	710
4	715	710
5	713	710
6	713	714
7	713	711
8	713	710
9	713	709
10	713	708
11	713	708
12	713	708
13	713	709
14	713	710

Inlets and feeder pipes will have 2' of pervious fill all around and a 1' deep layer of graded gravel with the same area as the inlet opening at inlets.

By using this fill plan the inlets and feeder pipes will not have uplift forces on them above grate elev.

NRH 1-91

✓ GRS 1/91

MANHOLE	No. of INLETS	SIZE of INLET
1	1	4'x16'
2	2	4'x6'
3	1	4'x10'
4	1	4'x12'
5	1	4'x12'
6	1	4'x8'
7	2	4'x6'
8	1	4'x4
9	1	4'x4'
10	2	4'x4'
11	1	4'x6'
12	1	4'x4'
13	2	4'x4'

Table based on 24"φ R.C.P. feeder pipes into 48"φ M.H. riser. Pipes must be greater than 104° apart.

Inlets

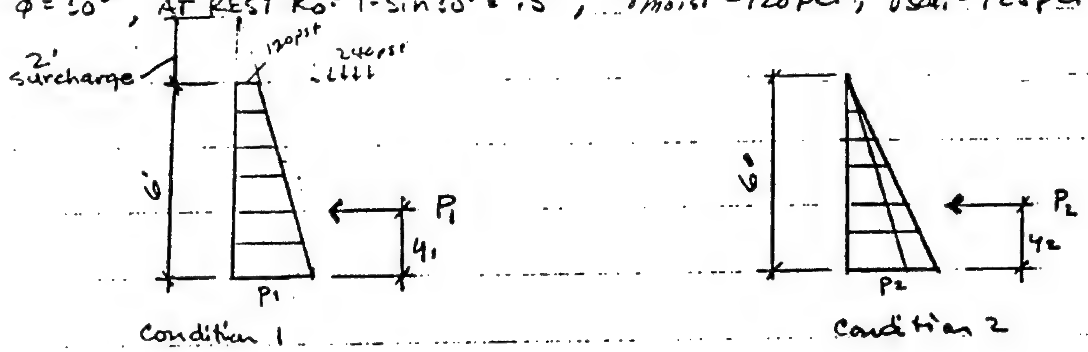
Assume deepest inlet 6'-0" deep

Design for worst of two conditions:

1. moist soil + 2' surcharge
2. water table to grating El.

Lateral pressure: Pervious material

$\phi = 30°$, AT REST $K_o = 1 - \sin 30° = .5$, $\gamma_{moist} = 120$ pcf, $\gamma_{sat.} = 125$ pcf



$P_1 = K_o \gamma_{moist} H = (.5)(.120)(8')$ $\qquad$ $P_2 = K_o \gamma_{sub.} H + \gamma_{water} H$

$= .480$ KSF $= .120 + .360$ $\qquad$ $= [(.5)(.125 - .0625) + (.0625)](6) = .563$ KSF

$P_{1A} = (.120)(6) = .720^{k/}$, $y = \frac{6}{2} = 3'$ $\qquad$ $P_2 = (.563)(6)/2 = 1.69^{k/}$, $y = \frac{6}{3} = 2'$

$P_{1B} = \frac{(.360)(6)}{2} = 1.08^{k/}$, $y = \frac{1}{3}(6) = 2'$

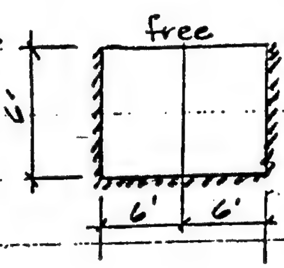
$M_1 = (.72)(3) + (1.08)(2) = 2.16^{'k} = 26^{''k}$ $\qquad$ $M_2 = (1.69)(2) = 3.375^{'k} = 40.5^{''k}$ ← worst

Determine wall thickness.-

Condition 2 controls - use this load, but moment can be reduced by using box shape. Largest inlet 12' long.

Use Monograph of tables used for rectangular plates + slab - moment + shear coeff.

Fixed on 3 sides. $a/b = 6/6 = 1$



Inlets

Figure 4: $R_y = .4584$

Max. shear $= (.4584)(.563)(6) = 1.55^k$

10" thick walls min. $d = 10 - 2.5 = 7.5''$

$V_u = 1.7 \times 1.55 = 2.63^k$

✓ $\phi V_c = (.85)(.126)(12)(7.5) = 9.64^k > 2.63^k$

Figure 4: $M_y = .0845$

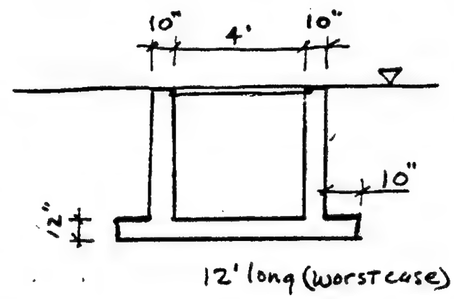
Max. Mom. $= (.0845)(.563)(6)^2 = 1.71'^k = 21''^k$

$M_u = 1.7 \times 21 = 35''^k$

$\rho_{max} = .75\rho_b = .007126 \qquad d = 7.5''$

✓ $\phi M_n = (.9)(60)(.007126)\left[1 - \frac{(60)(.007126)}{(1.7)(4)}\right](12)(7.5)^2 = 4.33(7.5)^2 = 243''^k > 35''^k$ ok

Flotation ETL 1110-2-307



$U = (.0625)(7')(5.66')(13.67') = 33.89^k$

W_s (concrete) $= (.15)\{(1.0')(7.33')(15.33') + (.83')(6')(35.33')\} = 43.36^k$

W_s (grating) $= .19^k/' \times 12' = 2.28^k$

TRY 10" slab extensions

$U - W_g = (.0625)(1.0')(.83')(42') = 2.19^k$

W_s (concrete) $= (.15)(1.0')(.83')(42') = 5.25^k$

W_s (soil) $= (.120 - .0625)(6')(.83')(42') = 12.07^k$

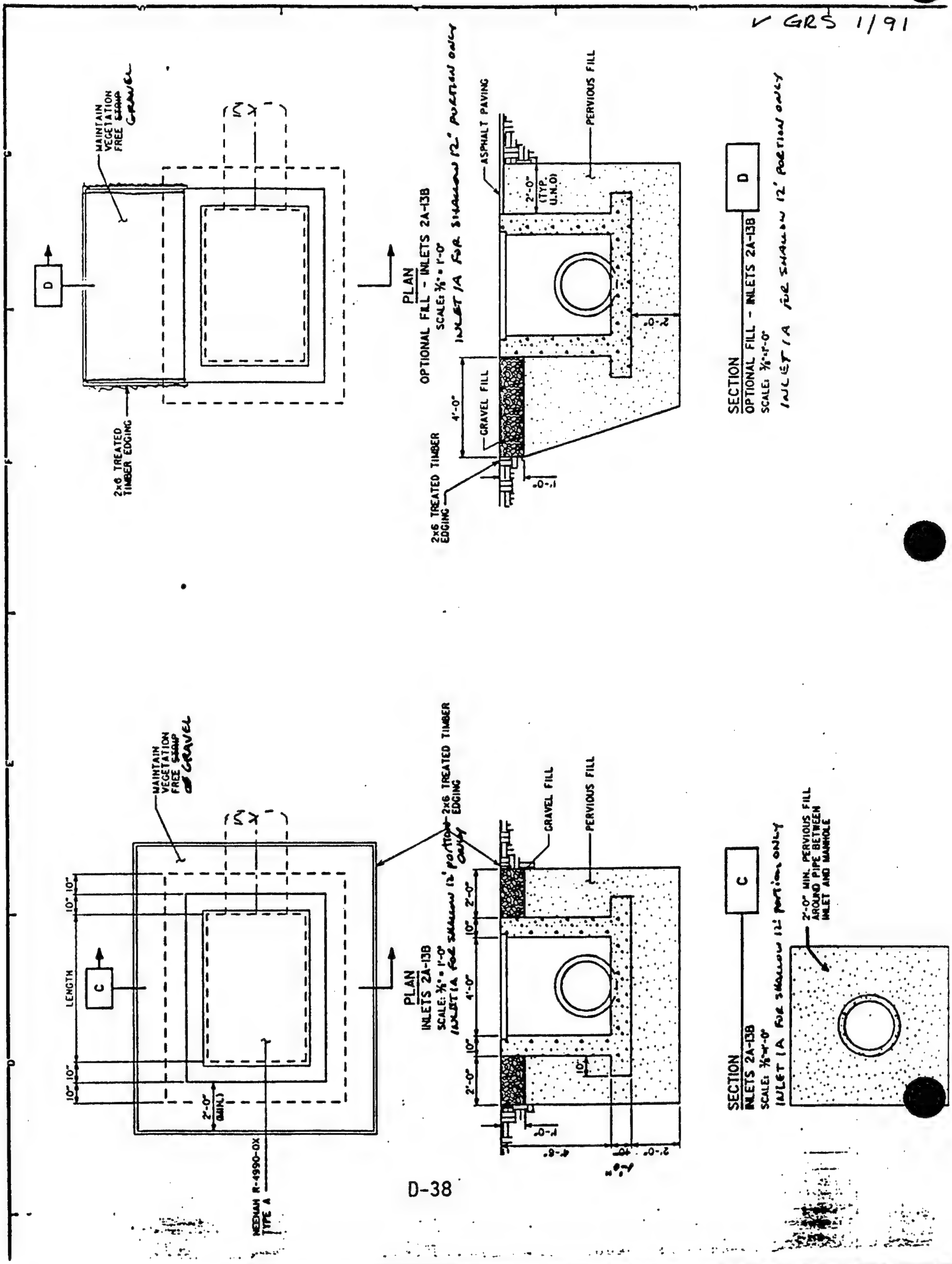
F.S. $= W_s / U - W_g = 43.36 + 2.28 + 5.25 + 12.07 / 33.89 + 2.19 = 1.75 > 1.5$ (ok)

Use 12" slab so there will be two layers of reinforcing and one layer will extend into 10" slab extensions

NRH 1-24-91

✓ GRS 1/91

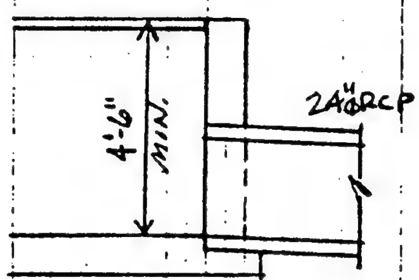
INLET



NRH 12/20/90
✓GRS 1/91

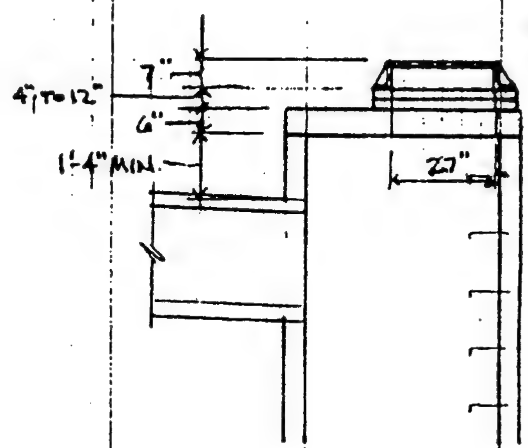
USE SAME NOTES AS
CITY OF CHASKA
STANDARD DETAIL PLATES
STD-3

NEENAH
R-4990-OX TYPE A



INLET

NEENAH
R1642



STORM SEWER MANHOLE
WITH REINFORCED TOP SLAB

Determine D-load at 0.01-in. crack

Reference: American Concrete Pipe Assoc. Design Manual

Determine Pipe Class as specified in ASTM C76.

ASTM C76 Class Circular RCP	D-load to produce a 0.01-in. crack (pounds/L.F./FT. dia.)
I	800
II	1000
III	1350
IV	2000
V	3000

$$\text{D-load} = \left(\frac{W_L}{1.5} + \frac{W_E}{L_f}\right)\frac{F.S.}{D} \quad \text{(Equation 33a)}$$

W_E = Earth Load (Tables 13-42) (increase backfill loads from tables by 20% for backfill weighing 120pcf)

W_L = Live Load (Table 45)

L_f = Load Factor (Figure 227)

F.S. = Factor of Safety (page 42)

D = pipe inside diameter

Trench condition

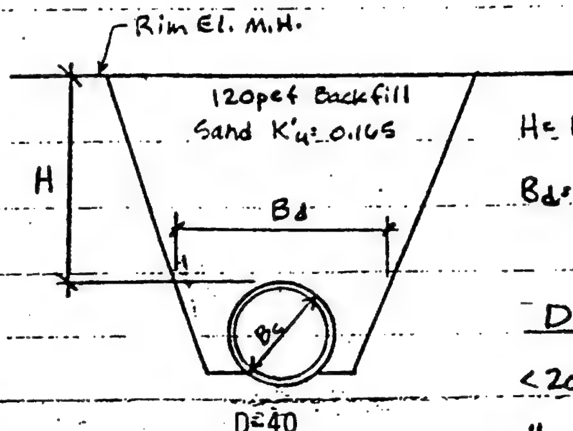
Ordinary Bedding

$L_f = 1.5$

Factor of Safety

F.S. = 1.0

F.S. = 2.0 (in levees)



H = Height of fill above pipe

Bd = trench width at top of pipe

D	Max. Bd
< 20"	Bc + 12"
20"–48"	Bc + 24"
> 48"	Bc + 36"

Interceptor RCP - Worst case for each size

D (in.)	H (ft.)	B_d (ft.)	W_E (#/ft.)	W_L (#/ft.)	D-load	ASTM C7 class
24"	8.17'	4.50'	3317	270	1196	III
30"	14.21'	5.08'	4712	—	1256	III
36"	9.19'	5.67'	4840	290	1140	III
42"	7.13'	arch 8'	5064	500	1060	III
48"	9.10'	6.83'	6034	380	1069	III
54"	7.84'	arch 10'	6779	490	1077	III
60"	8.56'	9.00'	7931	515	1126	III
66"	9.26'	9.58'	9104	430	1156	III
72"	13.92'	10.17'	13410	—	1590	III
18"	9.21'	2.92'	2004	170	966	III
Feeder pipes						
24"	2'	4.50'	600	1780	794	II
Relief well drain pipes	Worst case M.H. 6					
12"	14.21'	2.33'	1430	-	960	II

→ Use ASTM C76 Class III interceptor RCP for all sizes

→ Use ASTM C76 Class II for feeder pipes betw. inlets and M.H.

Outlet Pipes (in levee)

Determine D-load at 0.01-in. crack

Reference: American Concrete Pipe Assoc. Design Manual

EM 1110-2-2902 "Conduits, Culverts + Pipes"

Determine pipe Class as specified in ASTM C76 or ASTM C655

OUTLET C	B	D (in)	H (ft.)	B_d (ft.)	We (#/ft.) 120pcf	W_L (#/ft.)	D-load	class
40'	40'	48	El. 725 37.5	8'	18,318	–	6106	ASTM C655 D-load 6000
60'	60'	48	El. 711.5 24	8'	14,628	–	4876	ASTM C655 D-load 5000
–	NO	48	El. 699.25 11.83'	8'	8985	–	2995	ASTM C76 V
125'	30' 130'	48	El. 692. 4.5'	8'	2970	–	990	II
35'		66	El. 729 30'	10'	22,848	–	5540	ASTM C655 D-load 6000
55'		66	El. 724 25'	10'	20,424	–	4950	ASTM C655 D-load 5000
35' 120'		66	El. 712 12.5	10'	12,287	–	2980	V
	40'	72	El. 729 29.5'	11'	25,836	–	5740	ASTM C655 D-load 6000
	50' 90'	72	El. 723.5 23.5'	11'	22,260	–	4950	ASTM C655 D-load 5000

NRH 1-28-91

✓ GRS 1/91

Interceptor RCP

18" Class III

24" class III

30" class III

36" class III

42" class III

48" class III

54" class III

60" class III

66" class III

72" class III

Feeder RCP from inlets to M.H.'s

24" class II

Relief well drain pipes

12" class II

Outlets	OUTLET B	OUTLET C
48" D-load 6000	80 L.F	80 L.F.
48" D-load 5000	120 L.F.	120 L.F.
48" Class II	60 L.F.	50 L.F.
72" D-load 6000	40 L.F	
72" D-load 5000	50 L.F	
66" D-load 6000		35 L.F.
66" D-load 5000		55 L.F
66" class V		35 L.F.

Chaska Stage 4 FDM. NRH 12/11/90 ✓GRS 1/91

REFER: ETL 1110-2-307 Flotation Stability Criteria for Hydraulic Structures
EM 1110-2 3104 Appendix B - Struc. + Arch. Design of Pumping Stations.

BOUYANCY OF MANHOLES AND TEES

Condition A:

- Uplift designed for uplift head at specific location.
- Soil saturated.
- water in pipe up to lowest operating range of pumps El. 698.
- F.S. = 1.5

Condition B:

- Uplift designed for water table at El. 700.
- Pipe empty
- F.S. = 1.5

Condition C:

- Uplift designed for uplift head at specific location
- soil saturated
- water in pipe to lowest elev. pumps will pump to if malfunctioning. El. 695
  this could only occur between inlets 7 + 13. Inlets 1 thru 6 same as condition A.
- F.S. = 1.1

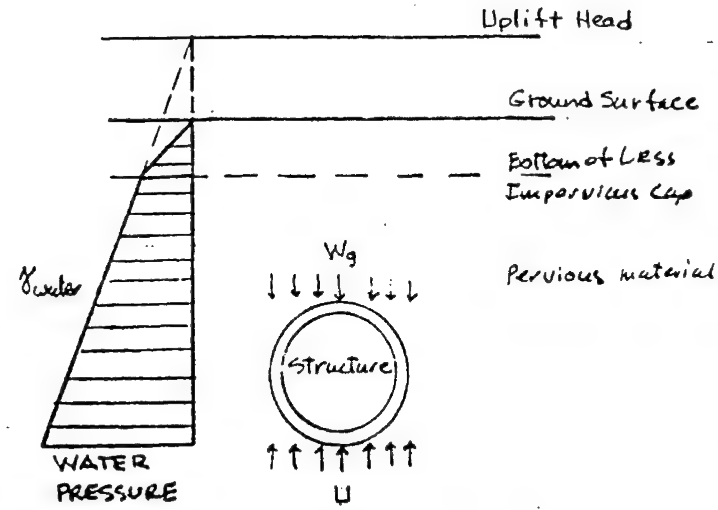
NRH 1-11-91
✓ GRS 1/91

Flotation – structures below ground water

$F.S. = W_s + W_c + S / U - W_g$ ETL 1110-2-307

For definition of symbols see reference.

(U-Wg) will be used in floation calculations as the weight of water displaced by the volume of the submerged portion of the structure.



CONDITION WITH UPLIFT HEAD ABOVE GROUND SURFACE

The submerged weight of soil above the structure will be decreased because of the head that must be dissipated in the top layer of less impervious material. The decrease in the weight will be the weight of water in the volume above the structure between the uplift head and the ground surface.
Ws = submerged wt. of soil above the structure and the weight of the structure.

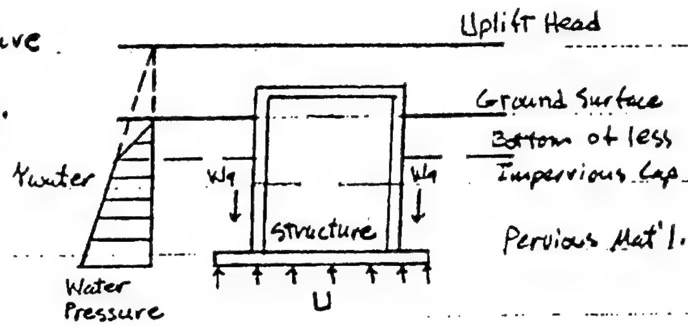
In this loading condition no surcharge load will be applied, since it would not be reasonable to have at the same time as highest river event and most of the structures are deep enough so surcharge would not be felt.

The above is Normal Operation and should have min $S.F_c = 1.5$

Flotation -

$F.S. = \frac{W_s + W_c + S}{U - W_q}$ ETL 1110-2-307 see for definitions of symbols.

U will be the water pressure up at the bottom of the structure using the Uplift Head Elevation.
Wq Will be the water pressure down on any part of the structure below the ground surface using the Uplift Head Elevation.



CONDITION WITH UPLIFT HEAD ABOVE GROUND SURFACE

The submerged weight of soil will be calculated the same as described for submerged structures.

Surcharge explanation is same as described for submerged structures.

The above is Normal Operation and has min. $SF_f = 1.5$.

page 40
NRH 1-16-91
✓ GRS 1/91

Flotation

M.H. 3 - 60" Interceptor O.D. = 6" + 60" + 6" = 72" = 6.0'

Inv. El. = 696.70 , Rim. El. 710 , ℄ El. of pipe = 699.20

Condition A: Uplift Head El. 715

Flotation of 60" Interceptor : 54"φ

$W - W_g = (.0625)(\frac{\pi}{4})(6.0)^2$ $= 1.77^k/L.F.$ ↑ 1.44

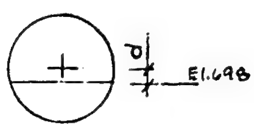
W_s (60" pipe) $= 1.325$ 1.095

W_s (soil) $= (.120 - \overset{.0575}{.0625})[(710 - \overset{10.8}{699.20})(6.0) - (\frac{\pi}{8})(6)^2]$

$-[(.0625)(715 \overset{5'}{-} 710)(6)] = 2.91 - 1.88$ $= \underline{1.04}$

$W_s = 2.36^k/L.F.$ ↓ 1.10

W_c



R = 2.5', d = 699.2 - 698 = 1.2' 1.05

$= [(2.5)^2 \cos^{-1}(\frac{1.2}{2.5}) - 1.2\sqrt{(2.5)^2 - (1.2)^2}](.0625)$ .406 $= 0.25^k/LF$ ↓ .12

F.S. = $W_s + W_c / W - W_g = 2.36 + .25 / 1.77 = 1.48 \sim 1.5$ (ok)

NRH 1-18-91

✓ GRS 1/91

Flotation

Check flotation of 48" ϕ riser M.H. 3

$U = (.0625)(715 - 701.7)(\frac{\pi}{4})(4.83)^2 = (.0625)(13.30)(18.35)$ $U = 15.25^k$

W_{s_1} (pipe betw. Rim El. + top of Tee Section)

$= (.885)(710 - \overset{6.8}{703.2}) + 1.11 \text{ top} = 6.02 + 1.11$ $= 7.13$

$W_{s_2}(\text{soil}) = -\{[(\overset{.0575}{.120 - .0625})(\overset{8.3}{710 - 701.7})(\frac{\pi}{4})\overset{18.35}{(4.83)^2}]$

$- [(.0625)(\overset{5'}{715 - 710})(\frac{\pi}{4})\overset{18.35}{(4.83)^2}] = -(8.76 - 5.73)$ $= -3.02$

$W_s = 4.11$

Flotation of Tee

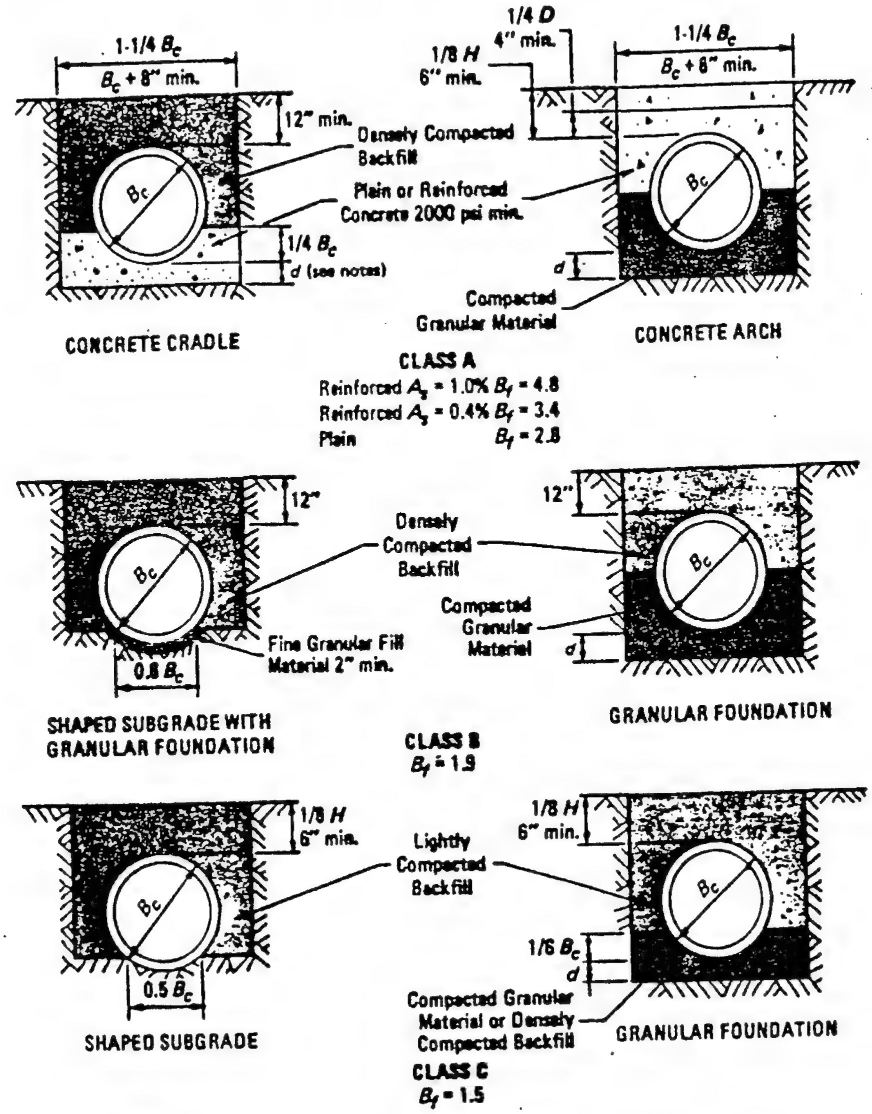
U(riser)		= 15.25
U-Wq (interceptor) = 1.77 × 12'		= 21.24
	Total U-Wq	= 36.49
Ws(riser)		= 4.11
Ws(interceptor) 2.36×12		= 28.32
	TOTAL Ws	= 32.43
Wc(interceptor) .25×12'	total Wc	= 3.00

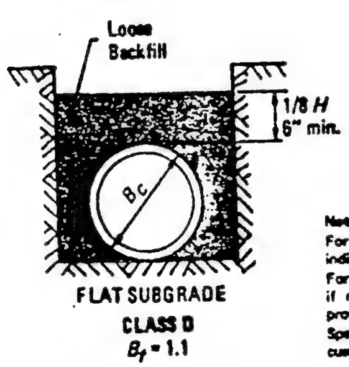
F.S. = Ws+Wc / U-Wq = 32.43 + 3.00 / 36.49 = 0.97 < 1.5 N.G.

Refer to Concrete Pipe Handbook -

Use Concrete Arch for weight. If the concrete cradle were used, metal straps would be required to tie pipe down to slab. there would be a possibility the tie downs would corrode. the concrete Arch cannot fail and works on gravity alone.

page 42





Depth of Bedding Material Below Pipe

D	d (min.)
27" & smaller	3"
30" to 60"	4"
66" & larger	6"

Legend

B_c = outside diameter
H = backfill cover above top of pipe
D = inside diameter
d = depth of bedding material below pipe
A_s = area of transverse steel in the cradle of arch expressed as a percentage of area of concrete at invert or crown.

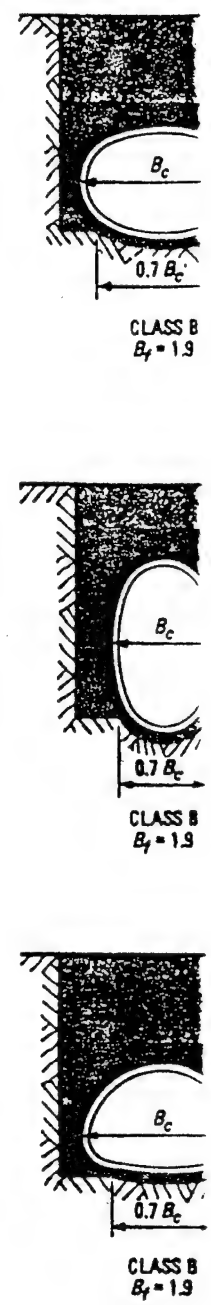
Notes:

For Class A beddings, use d as depth of concrete below pipe unless otherwise indicated by soil or design conditions.

For Class B and C beddings, subgrades should be excavated or over excavated, if necessary, so a uniform foundation free of protruding rocks may be provided.

Special care may be necessary with Class A or other unyielding foundations to cushion pipe from shock when blasting can be anticipated in the area.

Figure 9.16. Trench Beddings, Circular Pipe.

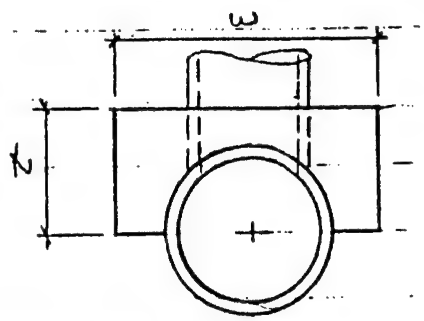


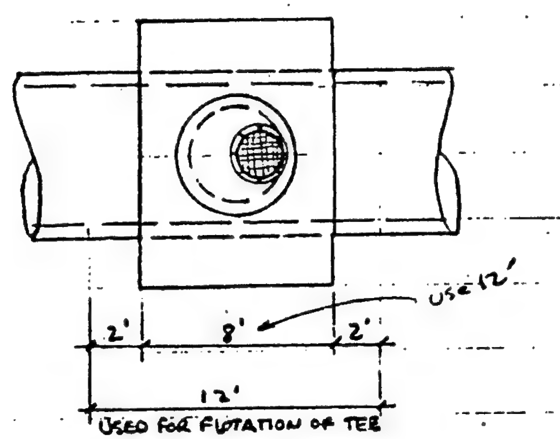
Figu

Flotation of Tee

M.H. 3

Determine size of concrete arch on tee to provide F.S. = 1.5 for flotation.





For 60" pipe:

$t = (1/4)(60") + (\frac{1}{2})(72") = 4.25'$

Try $w = 13'$, 8' long

$U - W_q$ = density of water x volume of structure submerged

$= (.0625)\left[(13)(4.25') + \frac{\pi}{8}(6)^2\right](8')$ = 34.70

U = density of water x volume of riser to uplift head taken from inside crown of interceptor

$= (.0625)(\frac{\pi}{4})(4.83)^2(715 - 701.7)$ = 15.25

$U - W_q$ = 2' of interceptor each side of tee

$= (.0625)(\frac{\pi}{4})(6)^2(4') = 1.77^{k}/' \times 4'$ = 7.07

Total $U - W_q$ = 57.02

W_{s_1} = concrete arch $= (.150)\left\{\left[(13)(4.25') - \frac{\pi}{8}(6)^2\right](8') - \left[(\frac{\pi}{4})(4.83)^2(1.75)\right]\right\}$ = 44.52

W_{s_2} = 48" pipe + top + 60" pipe = $6.02 + 1.11 + (1.325)(12')$ = 23.03

W_{s_3} = submerged wt. of soil above concrete arch minus density of water x volume between uplift head and ground surface $= [(.120 - .0625)(710 - 702.44) - (.0625)(715 - 710)]\left[(13)(8') - (\frac{\pi}{4})(4.83)^2\right]$ = 10.47

W_{s_4} = submerged wt. of soil above interceptor minus density of water x volume between uplift head and ground surface for 2' on sides of tee = $1.04^{k}/' \times 4'$ = 4.16

NRH 1-22-91

✓GRS 1/91

Flotation of Tee

M.H. 3

Total W_s = 82.17

W_c = water to El. 698 = $0.25^{k}/' \times 12'$ total W_c = 3.00

$$F.S. = \frac{W_s + W_c}{U - W_q} = \frac{82.17 + 3.00}{57.02} = 1.49 \sim 1.50 \text{ (ok)}$$

Try $w = 10.5'$, 12' long – Use 12' long concrete arch so joint at Tee section will not be over deflected from extra wt. of concrete, – also less excavation –

$U - W_q$ = density water × volume of structure submerged

$= (.0625)\left[(10.5')(4.25') + (\frac{\pi}{8})(6)^2\right](12')$ = 44.07

(14.14 is written above $(\frac{\pi}{8})(6)^2$.)

U = density water × volume of riser between uplift head + inside crown of interceptor

$= (.0625)(\frac{\pi}{4})(4.83)^2(715 - 701.7)$ = 15.25

Total $U - W_q$ = 59.32

W_{s_1} = concrete arch $= (.150)\left\{\left[(10.5)(4.25') - (\frac{\pi}{8})(6)^2\right](12') - \left[(\frac{\pi}{4})(4.83)^2(1.75)\right]\right\}$ = 50.06

(14.14 is written above $(\frac{\pi}{8})(6)^2$ and 32.11 above the second bracket.)

W_{s_2} = 48" pipe + top + 60" pipe = 6.02 + 1.11 + 15.90 = 23.03

W_{s_3} = submerged wt. of soil above concrete arch minus density of water × volume between uplift head and ground surface $= [(.120 - .0625)(710 - 702.44) - (.0625)(715 - 710)]\left[(10.5)(12') - (\frac{\pi}{4})(4.83)^2\right]$ = 13.15

(.1222 is written above the first bracket and 18.35 above $(\frac{\pi}{4})(4.83)^2$.)

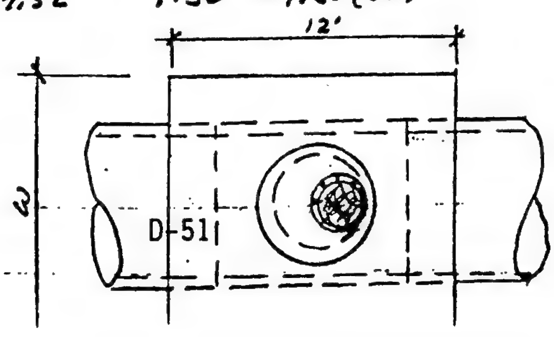
Total W_s = 86.24

W_c = water to El. 698 = $.25^{k}/' \times 12'$ Total W_c = 3.00

$$F.S. = \frac{W_s + W_c}{U - W_q} = \frac{86.24 + 3}{59.32} = 1.50 = 1.50 \text{ (ok)}$$

→ M.H.3 Concrete arch

size 10'-6" W × 12'-0" L × 4'-3" H



Flotation

M.H. 2 - 54" Interceptor dia. : 5½ + 54 + 5½ = 5'-5"

Inv. El. 698.0 , Rim El. 710 , ℄ Elev. of pipe 700.25

Condition A: Uplift Head El. 715

Check flotation of 54" Interceptor

$U - W_g = (.0625)(\frac{\pi}{4})(5.42')^2$ = 1.44 K/L.F.

pipe : 54" pipe = 1.10

soil: $(.120 - .0625)[(710-700.25)(5.42) - \frac{\pi}{8}(5.42)^2] - (.0625)(715-710)(5.42)$

$= (.0575)[(9.75)(5.42) - (11.52)] - (.0625)(5)(5.42) = 2.37 - 1.69$ = 0.68

W_s = 1.78 K/L.F.

F.S. = $W_s / U - W_g$ = 1.78/1.44 = 1.24 < 1.5 (N.G.)

Check 54" Interceptor at M.H. 3

Inv. El. 697.20 , Rim El. 710 , ℄ Elev. of pipe = 699.45

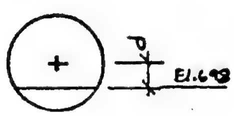
Condition A: Uplift Head El. 715

$U - W_g$ = $U - W_g$ = 1.44 K/L.F.

W_{s_1} = pipe = 1.10

W_{s_2} = soil = $(.0575)[(\overset{10.55}{710 - 699.45})(5.42) - \overset{11.52}{(\frac{\pi}{8})(5.42)^2}]^{2.63} - \overset{1.69}{(.0625)(\overset{5}{715-710})(5.42)}$ = 0.93

W_s = 2.03 K/L.F.

Wc =  R = 2.25' , d = 699.45 - 698 = 1.45'

$= [(2.25)^2 \cos^{-1}(\frac{1.45}{2.25}) - 1.45\sqrt{(2.25)^2 - (1.45)^2}](.0625) = W_c = 0.12$ K/L.F.

$F.S. = \frac{W_s + W_c}{U - W_g} = \frac{2.03 + .12}{1.44} = 1.49 \approx 1.50$

∴ Concrete arch needed for wt. on 54" interceptor betw. M.H.'s 2 + 3.

NRA 1-22-91

✓GRS 1/91

Flotation

Determine size of concrete arch for 54" interceptor based on Elevations at M.H.2. (see figure for 42")

for 54" pipe : $t = \frac{54"}{4} + \frac{65}{2} = 46" = 3.83'$

Try $w = 7'\text{-}0"$

$U\text{-}W_q = (.0625)[(7')(3.83') + (\frac{\pi}{8})(5.42')^2]$ (11.52) $\qquad U\text{-}W_q = 2.40^k/\text{L.F.}$

W_{s_1} = concrete arch $= (.150)[(7')(3.83') - (\frac{\pi}{8})(5.42)^2]$ (11.52) $\qquad = 2.29$

W_{s_2} = 54" pipe $\qquad = 1.10$

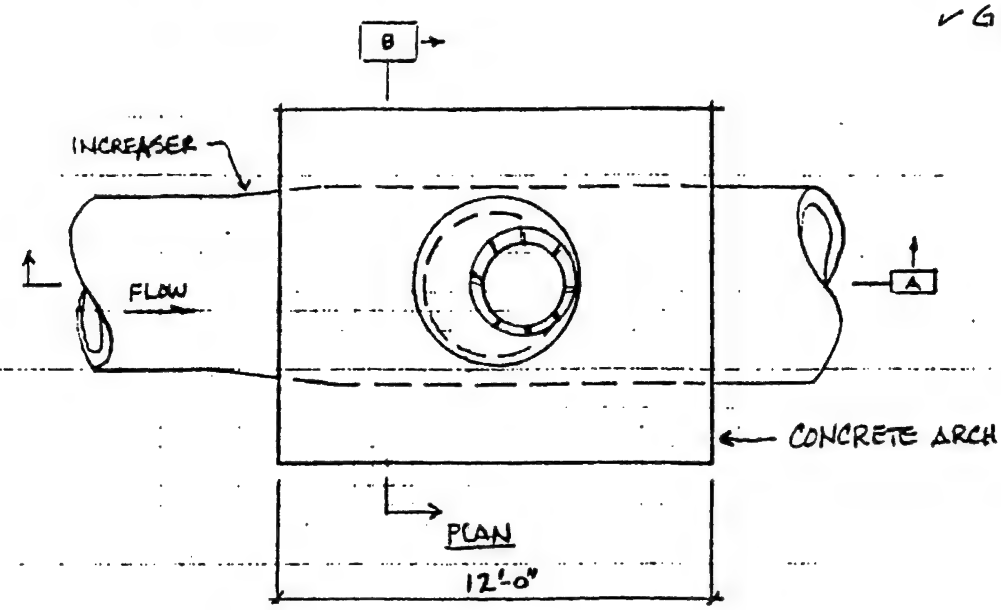
W_{s_3} = soil $= [(.0575)(710 - 704.08) - (.0625)(715 - 710)](7')$ (.34) (.31) $\qquad = \underline{0.19}$

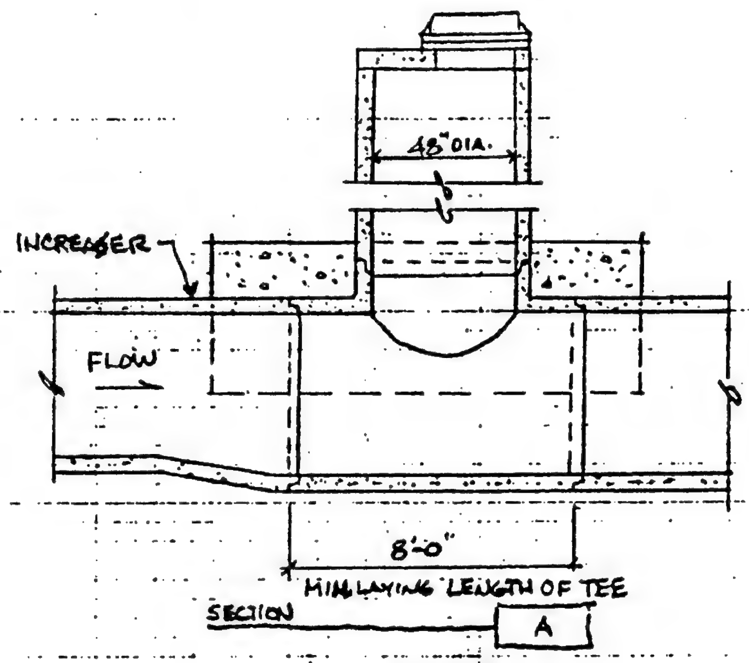
$W_s = 3.58^k/\text{L.F.}$

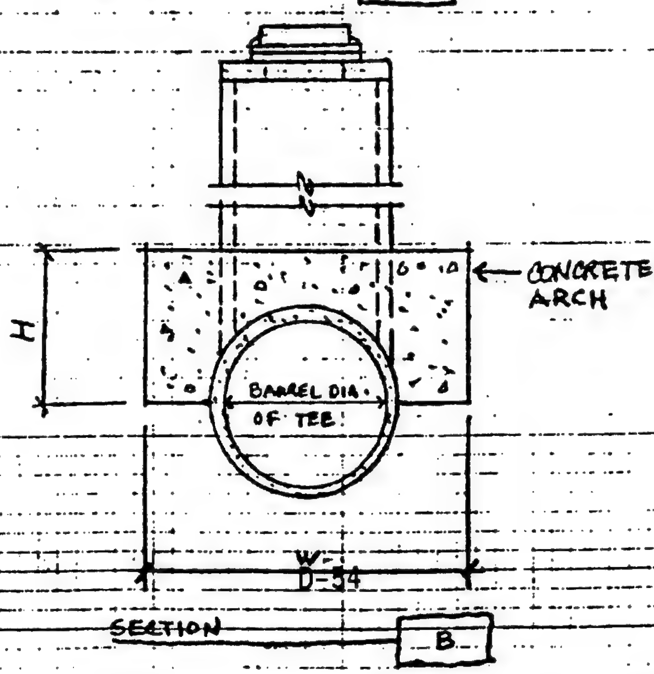
$F.S. = \frac{W_s}{U\text{-}W_q} = \frac{3.58}{2.40} = 1.49 \sim 1.50$ (ok)

→ Between M.H.2 and M.H.3 use concrete arch over pipe size 7'-0" W × 3'-10" H

RCP TEES + CONCRETE ARCH



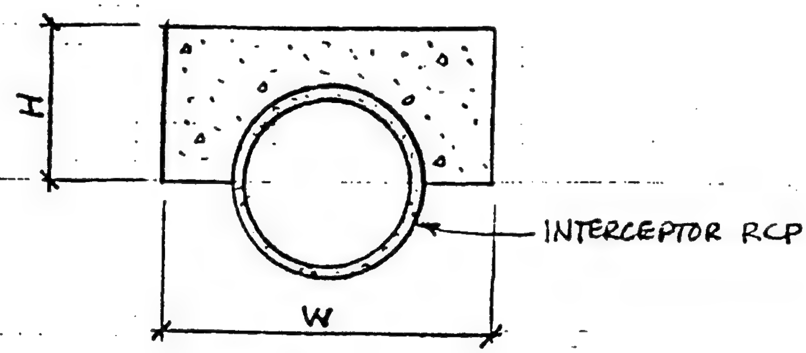




NRH 1-24-91

✓ GRS 1/91

RCP CONCRETE ARCH



SECTION

INTERCEPTOR BETWEEN M.H.'S	W	H
1 - 2	6'-0"	3'-0"
2 - 3	7'-0"	3'-10"

NKH 12/12/90

✓GRS 1/91

Floatation at M.H.'s

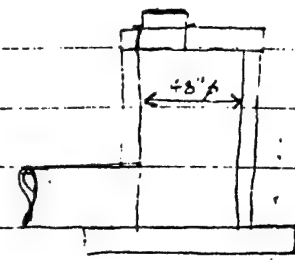
M.H. 13 – Straight M.H w/ slab cover

Inv. El. = 698.58 – Rim El. = 709.0

Check floatation of M.H.:

Condition A: Uplift head = 713 − 698.08 = 14.92'

$U = (14.92')(\frac{\pi}{4})(4.83')^2(.0625\,kcf) = 17.09^k \uparrow$



Weight: Ws

pipe: $(709 - \overset{10.42}{698.58})(.885) + \overset{2.22}{1.68}_{base} + 1.11_{top} = 12.01^k \downarrow$

wt. of pipe thru wall not subtracted. Assume this wt. will be there from pipe.

$F.S. = W_s/U = 12.01/17.09 = .70 < 1.5$ need slab extensions

Try 85"φ – 8" Thick base slab

$U_{TOTAL}: (.0625)(713 - 697.91)(\frac{\pi}{4})(7.08)^2 \qquad = 37.13$

$Wq_{TOTAL}: (.0625)(713 - 698.58)(\frac{\pi}{4}[(7.08)^2 - (4.83)^2]) \qquad = 18.97$

$U - W_q \qquad = 18.16$

Ws

Concrete: 9.22 pipe + 1.11 top + 3.94 base $\qquad = 14.27$

soil: $[(.12 - .0625)(709 - 698.58) - (.0625)(713 - 709)](\frac{\pi}{4})[(7.08)^2 - (4.83)^2] \qquad = 7.35$

$W_s = 21.62$

$F.S. = 21.62/18.16 = 1.17 < 1.5$ N.G.

Flotation

M.H. 13 (con't)

Try 92"ϕ - 8" thick base slab

$U = (.0625)(713 - 697.91)(\frac{\pi}{4})(7.67)^2 = 43.58$

$W_q = (.0625)(713 - 698.58)(\frac{\pi}{4})[(7.67)^2 - (4.83)^2] = 25.13$

$U - W_q = 18.45$

Concrete: 9.22 pipe + 1.11 top + 4.61 base = 14.94

soil: $[(.12 - .0625)(709 - 698.58) - (.0625)(713 - 709)](\frac{\pi}{4})[(7.67)^2 - (4.83)^2] = 9.73$

$W_s = 24.67$

$F.S. = W_s / U - W_q = 24.67 / 18.45 = 1.34$ N.G.

Try 92"ϕ - 18" thick base slab

$U = (.0625)(713 - 697.08)(\frac{\pi}{4})(7.67)^2 = 45.97$

W_q = from above = 25.13

$U - W_q = 20.84$

Concrete: 9.22 + 1.11 + 10.39 = 20.72

soil: from above = 9.73

30.45

$F.S. = 30.45 / 20.84 = 1.46$

Flotation

M.H.13 (con't)

Try 96" ϕ -18" thick base slab

$U = (.0625)(713-697.08)(\frac{\pi}{4})(8)^2$ = 50.01 48.44

$W_g = (.0625)(713-698.58)(\frac{\pi}{4})[(8)^2-(4.83)^2]$ = 28.79

$U - W_g$ = 21.23

Concrete : 9.22 pipe + 1.11 top + 11.31 base = 21.64 17.81

Soil: $[(.12-.0625)(709-698.58)-(.0625)(713-709)](\frac{\pi}{4})[(8)^2-(4.83)^2]$ = 11.18

W_s = 32.82

$F.S. = 32.82 / 21.23 = 1.55 > 1.5$ ok

Determine net load on slab extension.

Uplift pres.: $50.01 / \frac{\pi}{4}(8)^2 = .99$ KSF over entire base

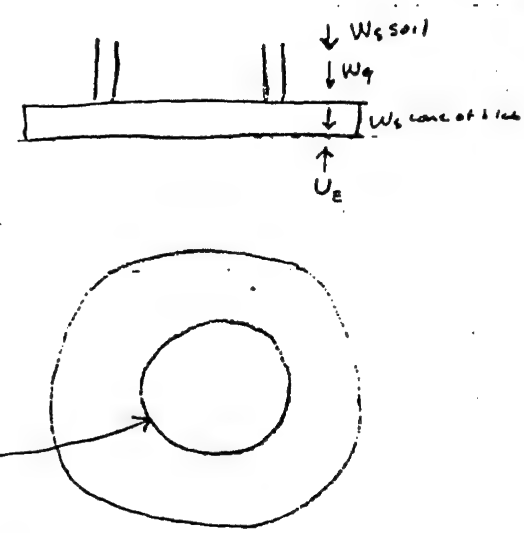
$U_E = (.99)(\frac{\pi}{4})[(8)^2-(4.83)^2] / \pi(4.83')$
$= 2.09$ K/FT. at M.H. wall

W_s conc. slab $= (.15)(1.5')[(\frac{\pi}{4})(8)^2-(4.83)^2] = 7.19^k$

$W_g + W_{s\,soil} + W_{s\,conc.\,slab}$

$= 28.79 + 11.18 + 7.19 / \pi(4.83') = 3.11^k/$

Net force down at wall = 3.11 - 2.09 = 1.02 K/FT.



Shear on 18" slab:

$V_u = 1.7 \times 1.02 = 1.73$ K/FT. $d = 18 - 3.5 = 14.5"$

$\phi V_c = (.85)(2\sqrt{4000})(12)(14.5) = 18.64$ K/FT. > 1.73 K/FT. (ok) 18" slab (ok)

Flotation
M.H. 13 (Con't)

→ USE 100"ϕ - 8" Thick base slab

Try 100"ϕ - 8" thick base slab

$U = (.0625)(713 - 697.91)\frac{\pi}{4}(8.33)^2$

$= (.0625)(15.09)(54.50)$ $\quad U = 51.40$

$(.0625)(713 - 698.58)(\frac{\pi}{4})[(8.33)^2 - (4.83)^2]$

$= (.0625)(14.42)(36.18)$ $\quad W_g = 32.60$

$18.80^k \uparrow$

Concrete: 9.22 pipe + 1.11 top + 5.46 base $\quad = 15.79$

soil: $[(.0575)(709 - 698.58) - (.0625)(713 - 709)](\frac{\pi}{4}\{(8.33)^2 - (4.83)^2\})$

$= [(.0575)(10.42) - (.0625)(4)](36.18)$ $\quad$ (.35) $\quad = 12.63$

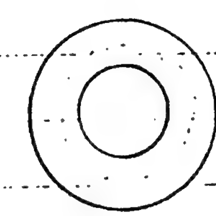
$W_s = 28.42^k \downarrow$

$F.S. = W_s / U - W_g = 28.42 / 18.80 = 1.51 > 1.5$ (ok)

Check strength of slab:

uplift pressure over bottom of slab - slab wt.

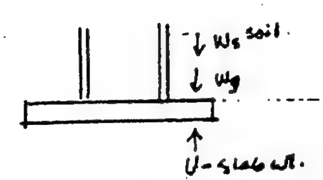
$= 51.40 / (\frac{\pi}{4})(8.33)^2 - (.15)(.67') = .94 - .10 = .84$ KSF



uplift on slab extension

$U = (.84\ KSF)(\frac{\pi}{4}\{(8.33)^2 - (4.83)^2\}) = 30.48^k$

Net force $= W_g + W_s$ soil $- U = 32.60 + 12.63 - 30.48 = 14.75^k$



lever arm $= (\frac{100 - 58}{2})(\frac{1}{2}) = 10.5"$

$M = (14.75)(10.5) / \pi(4.83') = 154.84''^k / 15.17' = 10.2''^k$ /l.f.

8" slab, d = 4" $\quad$ max $\rho = .007126$

$M_u = 1.7 \times 10.2 = 17.35''^k$

$\phi M_n = (.9)(60)(.007126)\left[1 - \frac{(60)(.007126)}{(1.7)(5)}\right](12)(4)^2 = 70.17''^k > 17.35$ (ok)

$V_u = 1.7 \times 14.75 / \pi(4.83) = 1.65^k$

$\phi V_c = (.85)(2\sqrt{5000})(12)(4) = 5.77^k > 1.65^k$ ok

Minimum angle between pipes in round M.H. ✓GRS 1/91
Refer to North Star M.H. Barrel size Determination

M.H. 8 36"ϕ + 30"ϕ pipes , 60"ϕ M.H.

$$K = \frac{18"+4" + 15" + 3.5" + 14"}{\Delta} = \frac{54.5"}{\Delta}$$

Table 1 for 60" M.H. K = .52"/°

min Δ = 54.5"/K = 54.5"/.52"/° = 104° ← min. angle

M.H. 7 30"ϕ + 30"ϕ pipes , 60"ϕ M.H.

$$K = \frac{15+3.5+15+3.5+14"}{\Delta} = \frac{51}{\Delta}$$

Table 1 for 60" M.H. K = .52

min Δ = 51/K = 51/.52 = 98°

M.H. 13 18"ϕ + 24"ϕ pipes , 48"ϕ M.H.

$$K = \frac{12+3+9+2.5+14}{\Delta} = \frac{40.5}{\Delta}$$

Table 1 for 48"ϕ M.H.; K = .42

min Δ = 40.5"/.42"/° = 96°

48"ϕ M.H. 24"ϕ + 24"ϕ pipes , feeder pipes from inlets

$$K = \frac{12+3+12+3+14}{\Delta} = \frac{44}{\Delta}$$

Table 1 for 48"ϕ M.H. : K = .42

min Δ = 44"/.42"/° = 104°

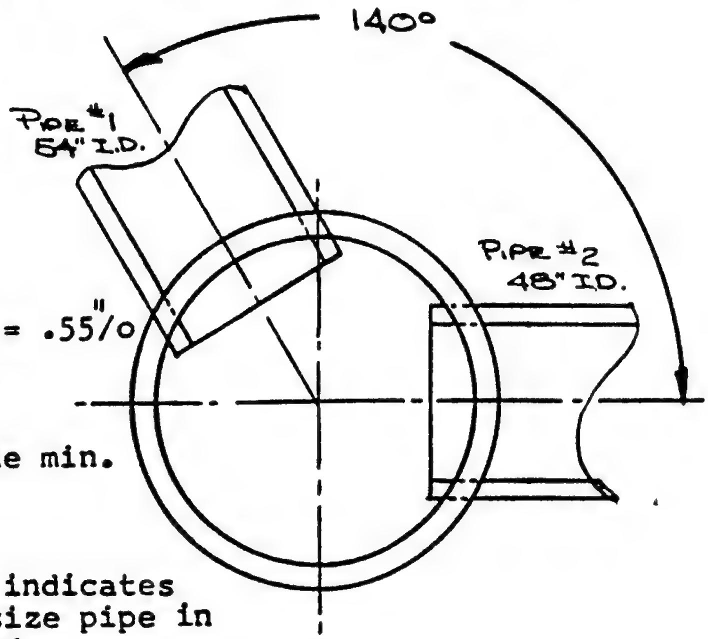
MANHOLE BARREL SIZE DETERMINATION

When determining minimum manhole dia. required for various pipe sizes and locations, two general criterias must be met.

a) Knowing the relative locations of any two pipes compute $K = \dfrac{R1 + T1 + R2 + T2 + 14''}{\Delta}$

b) MH or CB must be large enough to accept max. pipe as shown in table below.

Where R1 & T1 are interior radius & thickness of Pipe #1
R2 & T2 are interior radius & wall thickness of Pipe #2
Δ = Angle between pipe in degrees
NOTE: Refer to North Star Plates A-1, or A-3 for wall thickness



Example:

Given: Pipe #1 = 54" I.D., C wall
Pipe #2 = 48" I.D., C wall
Δ = 140°

Check for (a) above.

$$K = \frac{27'' + 6.25'' + 24'' + 5.75'' + 14''}{140^\circ} = \frac{77''}{140} = .55''/o$$

..r K = .55"/Δ the table below indicates the min. ..ze M.H. Barrel to be 66"

Check for (b) above
For the 66" MH Barrel, the table below indicates a max. pipe size of 42". As the max. size pipe in the example is 54", a 78" MH must be used.

Therefore, for this example, spacing is not critical & the maximum pipe size (criteria b) governs. Had the Δ angle been 113° or less, the spacing (criteria a) would be critical & a larger manhole barrel would be required.

Table I

MH or CB Dia.	K factor "/o	Max. Pipe Size
27"	.24	15"
42"	.37	24"
48"	.42	27"
54"	.47	33"
60"	.52	36"
66"	.58	42"
72"	.63	48"
78"	.68	54"
84"	.73	60"
90"	.79	60"
96"	.84	60"
102"	.89	60"
108"	.94	60"

NOTES:
1. Formula (a) allows for min. 14" "Leg" between pipes #1 & #2.
2. Should 3 or more pipes be required, each set of pipes should be studied separately with the respective Δ angle.
3. It is assumed the flowlines are approximately the same.

APPENDIX E

ARCHITECTURAL MECHANICAL ELECTRICAL

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX E

ARCHITECTURAL-MECHANICAL-ELECTRICAL PUMP STATION DESIGN

TABLE OF CONTENTS

Item	Page No.	Para No.
ARCHITECTURAL	E-1	1-5
MECHANICAL		
Hydraulic Parameters	E-2	6
Station Configuration	E-2	7-11
Pumps	E-3	12,13
Discharge	E-3	14
Crane	E-3	15
Heating & Ventilating	E-3	16-18
Sluice Gate Operators	E-3	19
Operation	E-3,4	20-23
References	E-4	
ELECTRICAL		
Service	E-4,5	24-26
Station Power and Lighting	E-5	27,28
Pump Motors	E-5	29,30
Control System and Control Panels	E-5-7	31-33
Wire and Cable	E-7	34,35
Grounding	E-7	36
DESIGN COMPUTATIONS		
Mechanical	E-8-13	
Electrical	E-14-26	

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX E

ARCHITECTURAL-MECHANICAL-ELECTRICAL PUMP STATION DESIGN

ARCHITECTURAL

1. The pump station, located at the end of Oak Street has been designated by the local sponsor as their "Center of Operations" during a flood emergency. The operations area (superstructure) contains approximately 500 gross square feet and provides an enclosure for the equipment and personnel area, with enough space for the local sponsor to provide a desk and file cabinet for project records. A total of five parking spaces have been provided for employee and emergency vehicles.

2. The pump station derives its design both aesthetically and functionally from the purpose it serves. The brick compliments and is consistant with adjacent residential brick homes in design, detail, and color. The uneven gabled ends are in relation to the the slope of the levee and deminish the superstructure to a more proportional scale, while maintaining the required headroom for the overhead monorail.

3. The roof structure is composed of two glue laminated trusses at the third points of the operations area and treated wood nailers on the concrete end walls. A tongue and groove wood roof deck with a standing seam metal roof will provide low maintenance and a durable finish. The monorail is supported independently of the roof structural system. A steel beam runs from the gabled dormer facing Oak street to the back wall facing the levee. This beam supports the midpoint of the monorail. The ends of the monorail are supported by concrete corbels at the gabled ends.

4. High windows in each of the three gables provide natural light into the station. The double doors on the Southeast side of the station serve two functions: one, to provide access to the monorail while servicing pumps and secondly the active leaf serves as the main entrance into the station. From this entrance point a stairway leads to the forebay operations platform. Ladders with hatch covers lead to lower levels of the forbay and pump chambers.

5. The exterior treatment also includes lighting and metal safety railing. The brick masonry and reinforced concrete walls will provide a low maintenance, fire resistive, weather tight, long life building.

MECHANICAL

HYDRAULIC PARAMETERS

6. These parameters establish the physical criteria for designing the pump station.

Required Pumping Capacity - 18,000 gpm.
River Elevation at Gravity Gate Closure - 706.0 ft.
Float Setting Elevations -

Common Off	698.0 ft.
1st Pump On	701.5 ft.
2nd Pump On	702.0 ft.
3rd Pump On	702.5 ft.

10 year ponding elevation without pumping - 714.5 ft.
Maximum River Elevation - 729.0 ft.

STATION CONFIGURATION

7. The hydraulic parameters warranted the investigation of alternative configurations to include:

Submersible or vertical turbine type pumps.
Two or three pumps.
Integral or independent outlet gatewell.

Construction costs were the primary factor for comparing alternatives.

8. The requirement for automatic lubricators rendered the vertical turbine pumps noncompetitive on a cost basis. The submersibles' price advantage was realized in both the two and three pump configurations.

9. Costs for pumps, controls, inlet gates, discharge lines, and substructure were considered in comparing two vs. three pump alternatives. The requirement to maintain two thirds capacity with one pump inoperable established a 12,000 gpm pump size for the two pump alternative. The costs of the two altervnatives were effectively equal. The three pump alternative was selected because of its increased redundancy and eaier maintenance on the smaller sized equipment.

10. The gatewell and pump station were not combined for several reasons. The primary factor was the unusually deep pumping chamber which would have resulted with an in the levee station. Such a deep chamber (approximately 35 ft.) would have complicated the problems of trash rack raking, pump access, and station flotation. The added depth would have significantly increased construction costs. Locating the station in the levee would have made it less accessible and visually obtrusive.

11. Hydraulic Institute standards were used in sizing the sump and it's approaches.

PUMPS

12. The pumps will be submersible centrifugal storm water pumps. Three manufacturers, Flygt, ABS, and KSB have confirmed they can provide pumps complying with typical specifications and with the characteristics required for this project. Standard catalog curves for two suppliers are included with the calculations.

13. A sump pump is provided to dewater the forebay and pump chambers within three hours after the chamber has been drawn down to the minimum level. The sump pump can be removed for maintenance through the forebay access hatch with a portable hoist. A sketch of a portable hoist is included with the calculations.

DISCHARGE

14. The discharges were sized to maintain a velocity of less than 12 fps for required pumping capacities. The pumps discharge into the gate well through flap valves located at the apex of the discharge lines. The discharge lines are ductile iron pipe which is the most economical material for this size line. The discharge lines can drain into the station without causing problems of pump cycling.

CRANE

15. An overhead monorail crane will permit removal of pumps to the open floor area for inspection, maintenance, and if necessay, removal by a service vehicle. The hoist will be slow speed to ensure stability during operation. The monorail beam's location will be adjustable within ± 4 inches along the station's longitudinal axis to ensure a vertical lift regardless of the actual pump and discharge installed.

HEATING AND VENTILATION

16. Sump ventilation, accomodating changing air volumes due to varying water levels, will be accomplished via motorized louvers located in the front wall of the pump chamber between the two operating levels.

17. Operating room ventilation will be accomplished through a powered exhaust located in the west gable.

18. Heat will be provided by two 5 kw electric space heaters. One will be thermostatically controlled while the other will be on/off controlled for transient conditions.

SLUICE GATE OPERATORS

19. The station's and gate wells' sluice gates will be operated with the portable operator or manually. The portable operator will be stored at the pump station. Factors considered in this decision were reliability, vandalism, construction costs, O&M costs, and operability. The portable operator will be sized for the 72 inch gate at outlet B.

OPERATION

20. The station is considered in operation any time the gravity outlets are closed. It is estimated this will occur once annually with a duration of one week. Minimal trash raking is anticipated because most of the flow is attributable to seepage.

21. Because of the station's depth, the forebay may flood during non flood events. This area can be dewatered with the sump pump if necessary. This area should be dewatered in the autumn to prevent freezing of any remaining water.

22. The substructure can be accessed through the pump chamber, forebay, and inlet chamber. Access is provided for inspection and repair purposes.

23. The pump chamber can be accessed for inspection purposes during operation. Ladders allow access to the discharge flange.

MECHANICAL REFERENCES

EM 1110-2-1410 Interior Drainage of Leveed Urban Areas: Hydrology, May 1965.

EM 1110-2-3102 General Principles of Pumping Station Design and Layout, December 1962.

EM 1110-2-3105 Mechanical & Electrical Design of Pumping Stations, December 1962.

ELECTRICAL

SERVICE

24. Electric power for the pumping station will be supplied by The City of Chaska Utility, the utility will provide 3-phase, 277/480-volt secondary electrical service to the storm water pump stations. They will install a padmount transformers adjacent to the pump station. The Construction contract will be required to construct a concrete pad in accordance with the cities specifications. The Utility will not permit full voltage starting of the pump motors used on this project. Reduced voltage starters will be required. The pumping station will receive underground, 3-phase, 277/480-volt secondary power. The service capacities for the station will be in accordance with the "Demand Load Analysis". The electrical equipment will be protected with suitable lightning arrestors.

25. The anticipated electrical loads will consist of:

submersible pumps - 3-100 hp
overhead crane - 2 hp
sum pump - 2 HP
electric heaters - 2-5 KW
sanitary lift pumps 2 - 10 hp (design and specification provided by the city)

26. The main circuit breakers will be key interlocking, with one breaker for the service from the power company and the other will be connected to a NEMA 4 junction box. The junction box will be mounted on the outside wall

of the station and have terminal lugs for connection of a city provided generator during power outages.

STATION POWER AND LIGHTING

27. The station will have a 100 amp 240/120 panel for lighting, and 120-volt convenience outlets. The station will have several 120 volt duplex GFI receptaclesin the structure. A separate circuit will provide power to exterior GFI receptacles. This circuit can be shut off during times of non-use so unauthorized personnel can not use them. Interior lighting will provide approximately 40 footcandles of light, there will also be an emergency light in case of power failure.

28. Exterior lighting will be provided near the doors and the gate operators.

PUMP MOTORS

29. The stormwater submersible pump motors will be housed in an air or oil-filled watertight casing and will have Class F insulated moisture resistant windings. Each motor will be equipped with temperature sensors for bearing and stator thermal protection and leak detectors for seal failure.

30. The motors will be designed to operate on a three-phase, 480-volt electrical system. The pump motors will have cooling characteristics suitable to permit continuous operation in a totally, partially, or non-submerged condition.

CONTROL SYSTEM AND CONTROL PANEL

31. Motor Control Center. The pump control equipment will be housed in free-standing motor control center. The enclosures will be fabricated from 12 gauge,cold rolled, hot-dipped galvanized steel with a gray baked enamel finish. Motor control sections shall be multiples of 20" wide by 20" deep by 90" high. The enclosures will be a NEMA 1 type. The motor control section shall be wired as a NEMA Class II type C with pull apart terminal blocks between sections. Power sections shall be constructed with horizontal and vertical bus enclosed in separate compartments with bus barriers for vertical and horizontal bus. The control operators, indicators and meters will be mounted on section doors, they will not be mounted below 30 inches or above 78 inches from the floor. The function of all major components and sub-assemblies will be identified with laminated, engraved plastic nameplates.

32. The city designed and specified control system for the relocated sanitary lift station shall be incorporated in the Motor Control Center. A telementary system incorporated in the Motor Control Center shall be provided for both the storm water and sanitary pump alarms. The following equipment will be furnished in the motor control center:

1) A Underwriter's Laboratories "Service Equipment Listed" main disconnect.

2) A three-phase, lightning and surge arrestor connected to phase conductors on the "Line" side of the service disconnect. The arrestor will protect the control panels against damage due to power system lightning strikes and surges.

3) A phase-sequence, phase-loss, under-voltage protection relay with adjustable nominal voltage settings complete with three extractor type line voltage fuses. This device will drop-out the pump if all phase voltages drop below 90% or if one phase drops below 80-83% nominal voltage. This device will have a 1/2 second dropout delay and an adjustable restoration time delay of up to five minutes.

4) A thermal magnetic molded case circuit breaker rated 22,000 amps-interrupting-current for short circuit protection of each pump motor.

5) A reduced-voltage magnetic motor starter with melting-element, ambient-compensated, quick-trip overload to provide overcurrent and running overload protection for each pump motor.

6) A door mounted "Hand-Off-Automatic" three position, rotary, oil-tight, weather-tight, heavy duty, NEMA 4 selector switch for each pump.

7) A door mounted "Pump Running" light operated from a motor starter auxiliary contact for each pump.

8) A control power circuit breaker.

9) A 100-watt, 120-volt condensation, "Strip" heater and adjustable thermostat for each motor control center section.

10) A running time meter measuring hours and tenths of hours of operation up to 9999.9 hours for each pump motor. These will be 110-volt, A.C. devices operating from the panel control voltage via an auxiliary contact of the motor starters.

11) Wet well level responsive automatic pump control and alarm system using five direct-acting liquid level sensors in the wet well. The Controller/Alternator will have five sensor test switches and indicating LED's, solid state alternation logic, lead pump alternation on successive starts, alternator manual over-ride control (Auto, 1-2-3, 2-3-1, 3-2-1), high level alarmand pump control load relays, independent "ON" and common "OFF" pump control.

12) A exterior mounted weatherproof, high water alarm horn and light. The alarm light will be the dim glow type and will glow brightly upon occurrence of an alarm condition.

13) Pump motor temperature and moisture sensing protective devices and control circuitry with manual reset to alarm and shut-down a pump in the event of abnormal operation.

33. Liquid Level Sensors. Level sensors will consist of a mercury switch mounted within a 5-1/2" diameter, type 316, stainless steel float assembly. The mercury switches will be rated for 20-amps at 120-volts. The supporting

control power cables will be extra-flexible with type "HSO" insulation jackets. The floats will be suspended in the wet well from a cable rack.

WIRE AND CABLE

34. The wire and cable used will be in accordance with guide specifications CE-1404.04, Insulated Wire and Cable (for Hydraulic Structures). Conductor material will be copper. Conductors will not be smaller than No. 12 A.W.G. Aluminum Conductors will not be permitted.

35. Conductors will be installed in conduit. Power cables will be sized for current-carrying capacity and voltage drop.

GROUNDING

36. All equipment will be grounded in accordance with the current edition of the National Electrical Code, NFPA 70 including connections to the steel hatch covers and discharge piping.

MECHANICAL ANALYSIS

PUMPING CONFIGURATION.

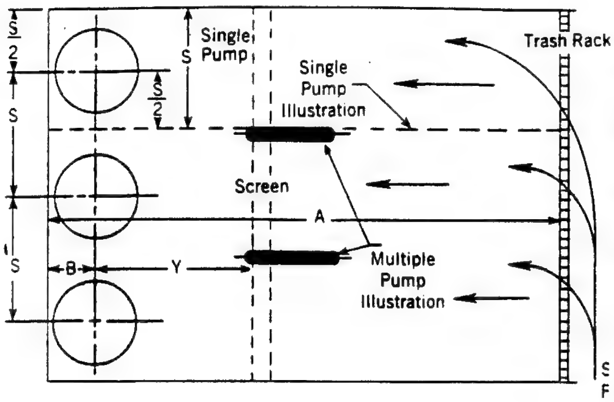
Determine the type (ie. radial, mixed, or axial flow) of pump based on capacity and head.

Number of Pumps	2	3
Capacity per pump (g.p.m.)	12,000	6,000
Approximate length of discharge line	120	120
Diameter of discharge line assuming 12 f.p.s.		
$12 \times ((4 \times Q)/(11 \times 12 \times 449))^{.5}$	20.2" (24")	14.3" (16")
Equivalent length of fittings (ft.)	169.8'	111'
24" 16"	60.4'	40'
3 - 90s @ 56.6' 37'		
2 - 45s @ 30.2' 20'		
Friction loss per 100 ft. (ft.)	0.962'	2.01'
Velocity Head (ft.)	1.42'	1.84'
Static Head (ft.) 729 - 698	31'	31'
TDH = 1.05 x (s.h. + v.h. + line losses)	35.8'	38.3'
BHP = gpm x TDH / (3960 x eff) eff = .7	155 hp	83 hp
Maximum pump speed (rpm)	993	1400

The heads could be achieved with either a mixed or radial flow pump. After comparing costs, vertical turbine pumps (with automatic lubricators) were eliminated. Therefore submersible pumps. Only one source carries a submersible mixed flow pump in these capacities. Therefore radial flow.

MECHANICAL ANALYSIS

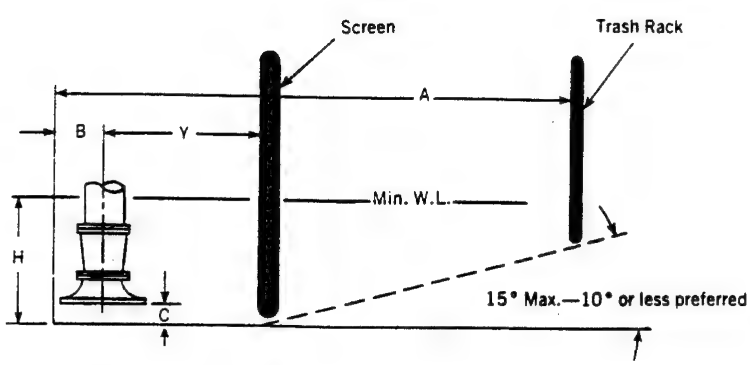
Determine whether two or three pumps based on construction costs.



Number of Pumps	2	3
	6-8 kgpm	12-14 kgpm
A	140"	200"
B	23+(50)"	33+(50)"
C	18"	22.5"
H	60"	80"
S	56"	73"
Y	95"	130"

Number of Pumps		2	3
Sump		$63k	$55k
Controls		$45k	$40k
Pumps		2 x $67k	3 x $35k
Discharge cost per linear foot	117 x	2 x $76	3 x $35
		$18k	$15k
Fittings (4 90s)		$17.6k	$8.6k
Gates & Operators		2 x $5k	3 x $3k
		========	=======
		$287k	$245k

The three pump option is economically justifiable.



MECHANICAL ANALYSIS

PUMP CYCLE TIME.

Ton	=	TOTAL MINUTES PUMP ON
Toff	=	TOTAL MINUTES PUMP OFF
Tcycle	=	TOTAL CYCLE TIME
V	=	PUMPING VOLUME BETWEEN H.W.L. AND L.W.L.
P	=	PUMPING RATE
Q	=	INFLOW
N	=	NUMBER OF PUMPS
PHI	=	CYCLES/HOUR

Critical inflow equals 1/2 the pumping rate. This inflow will cause the highest cycle frequency. Ton = Toff.

P = 6000 gpm.
Q = P/2 = 3000 gpm
V = 15 2/3' X 27 2/3' X (706 - 698) = 3,468 ft^3. = 25,941 gals.

Ton = 25,941/(6,000 - 3,000) = 8.65 minutes.
Tcycle = Ton + Toff = 2 X Ton = 17.3 minutes.
PHI = 60/(Tcycle x N) = 60/(17.3 x 3) = 1.2 cycles per hour.

PERFORMANCE CURVES.

REFER TO PAGE 1 FOR PUMP VERSION (H.H., STD.,etc.) and PUMP TYPE (CP,CT,etc.)

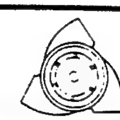
SECTION	PAGE
3355	8B
SUPERSEDES	ISSUED
———	9/83

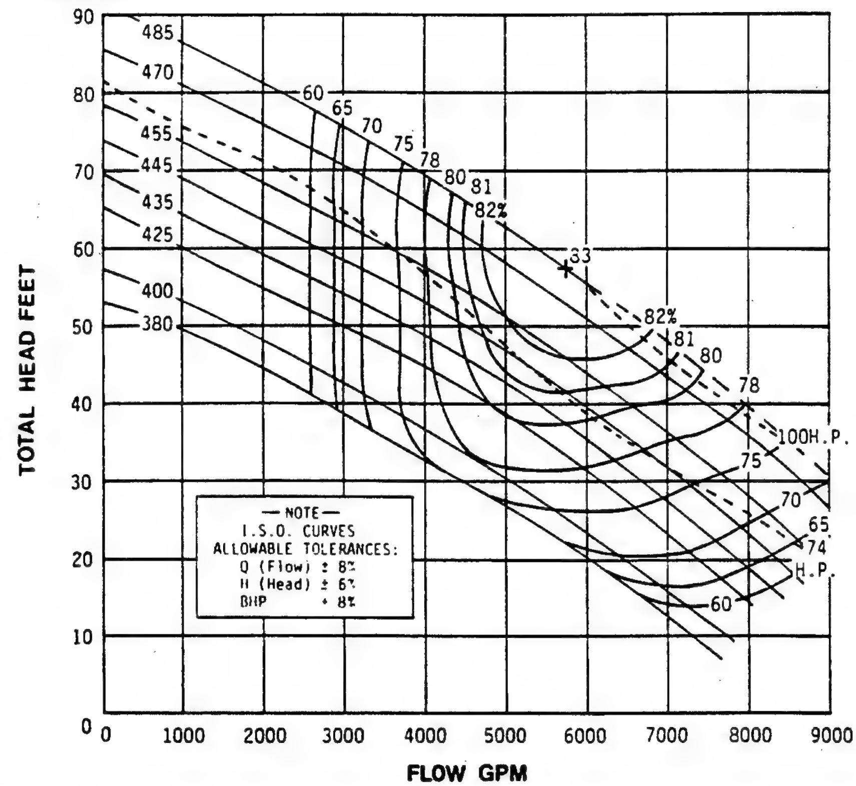
CP/CT-3355

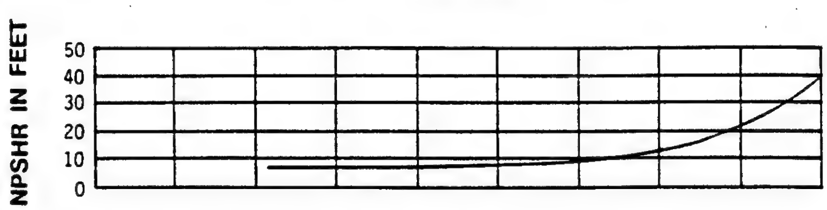
DETERMINE THE SYSTEM OPERATING SPAN ON THE PUMP CURVE SELECTED.
ALL PUMP CURVES OR PORTIONS OF PUMP CURVES BELOW THE 74 HP CURVE REQUIRE THE 74 HP MOTOR.
ALL PUMP CURVES OR PORTIONS OF PUMP CURVES ABOVE THE 74 HP CURVE AND BELOW THE 100 HP CURVE REQUIRE THE 100HP MOTOR ETC.

TO FIGURE KW INPUT AT DUTY POINT:

$$\text{Input KW} = \frac{\text{GPM} \times \text{Hd. in Ft.}}{3960 \times \text{Hyd. Eff.}} \times \frac{.746}{\text{Motor. Eff.}}$$

Consult Flygt Tech. Dept. For Motor information	WASTEWATER IMPELLER 810	





PERFORMANCE CURVES ARE BASED ON TESTS WITH CLEAR WATER AT AMBIENT TEMPERATURE.

FLYGT CORPORATION
A SUBSIDIARY OF ITT
129 GLOVER AVE., NORWALK, CT. 06856

SECT. 200 TAB 14" 3Ø PG. 131

DATE March 1, 1988

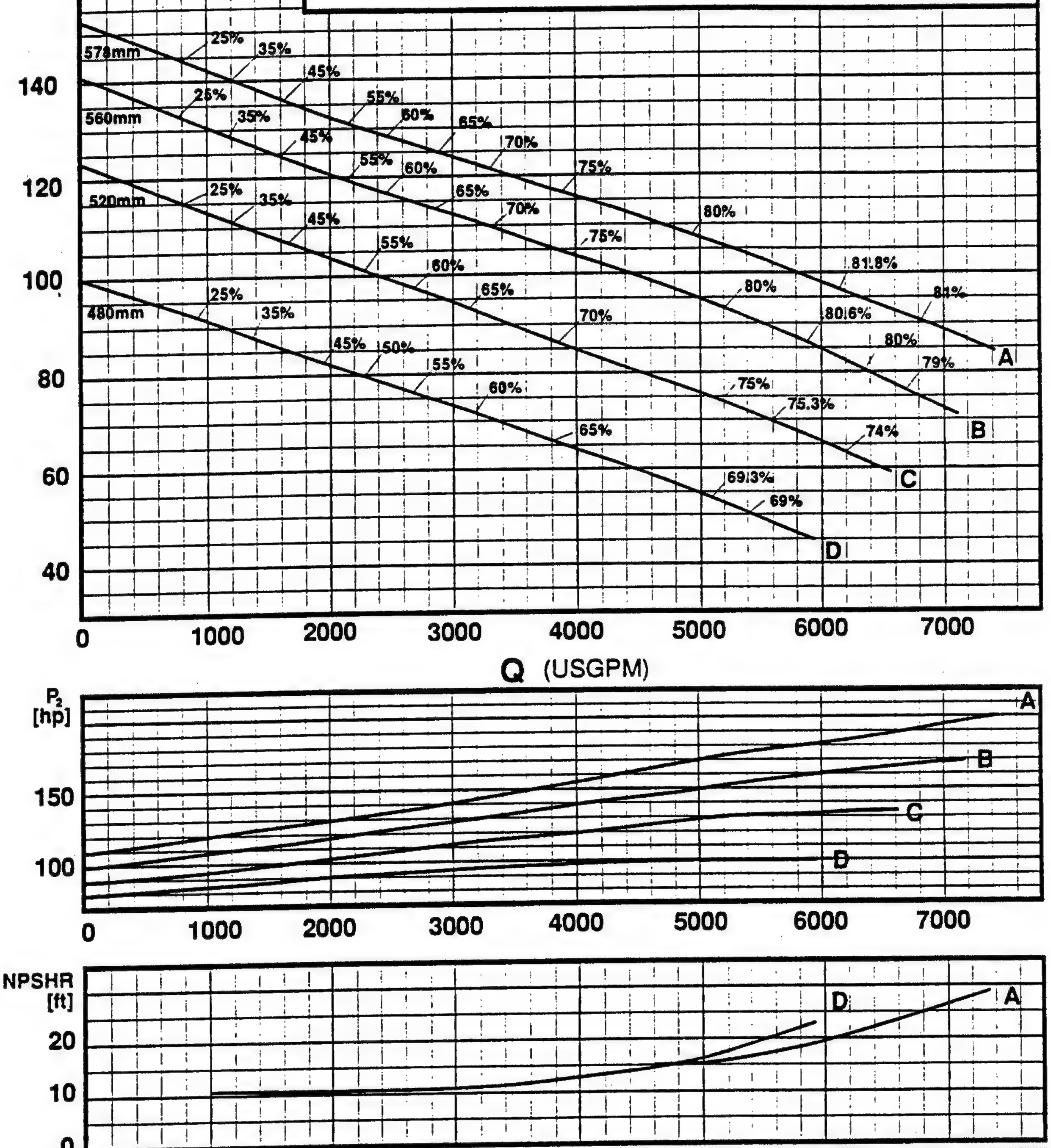
STANDARD

MODEL AF
RATED HP

750-8.W3.	900-8.W3.	1100-8.W4.	1320-8.W4.	1600-8.W4.
101	121	148	177	215

SOLID SIZE 6" BLADE 2 SPEED 870 RPM

DISCHARGE SIZE 14" VOLTAGE 460,600 ; 60 Hz 3 PH

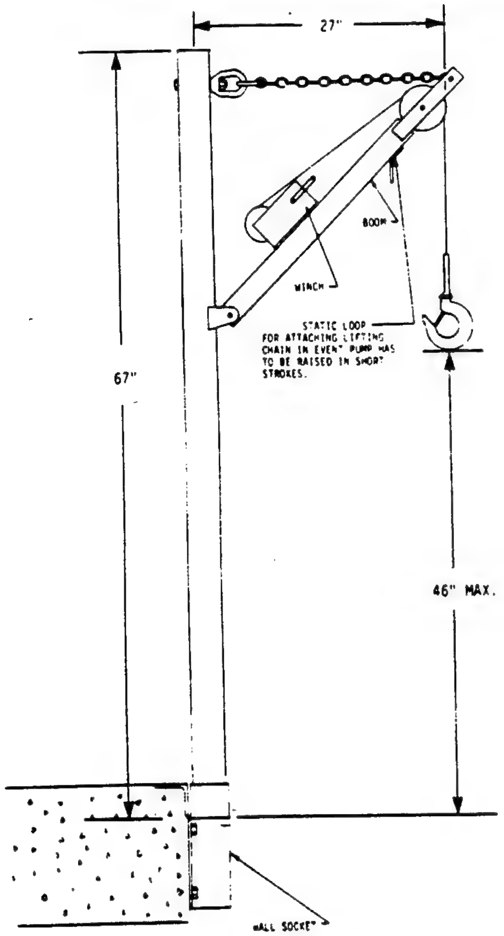


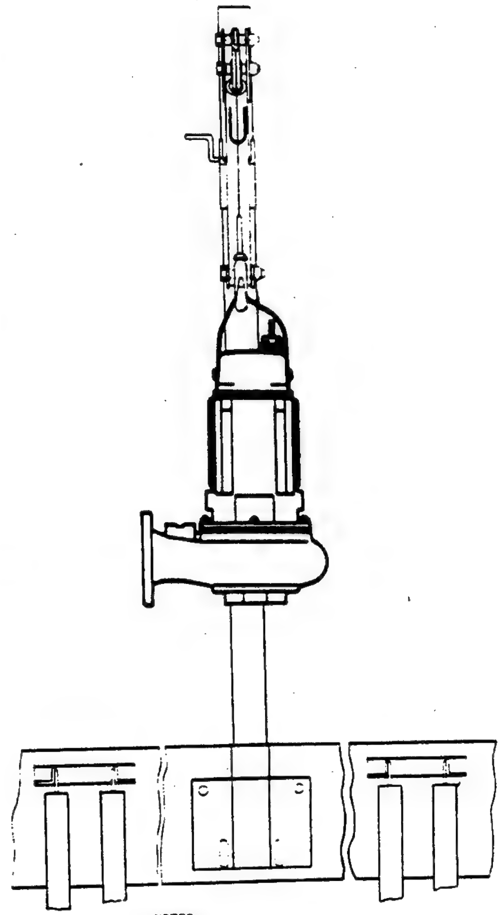
Hydraulic type: Closed impeller	Discharge Size **14"**
Wet end: GS 351	

ABS Pumps Inc. 140 Pond View Drive Meriden, CT 06450

PORTABLE HOIST

SECTION	PAGE
K	22
SUPERSEDES	ISSUED
	4/86

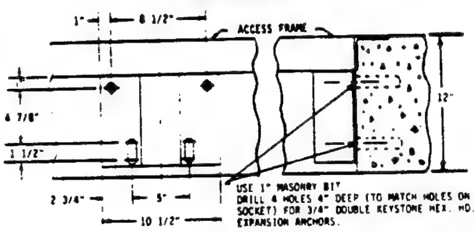


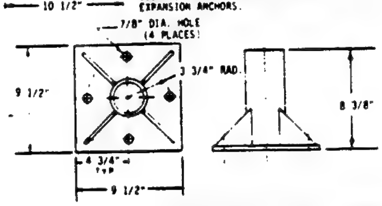


NOTES:

1. LUBRICATE INTERIOR SURFACE AND SHOULDER OF SOCKET WITH AXLE GREASE TO FACILITATE ROTATION OF HOIST.
2. MINIMUM CONCRETE DEPTH REQUIRED FOR WALL MOUNT INSTALLATION IS 12" - IF EXISTING PIT HAS LESS THAN 12" WALL, REFER TO ALTERNATE INSTALLATION DRAWING # 14587832.
3. SEE DRAWING # 14587831 FOR TYPICAL DUPLEX INSTALLATION OF WALL SOCKET.
4. PLATFORM SOCKET INSTALLATION DRAWING # 14587830.

WALL SOCKET (14587850)





PLATFORM SOCKET (14587840)

SPECIFICATIONS:

SAFE LOAD 650 LBS

WEIGHT: 60 LBS.

LIFT: 30 FT.

REACH: 27" MAX.

FLYGT

FLYGT CORPORATION

A SUBSIDIARY OF ITT

129 GLOVER AVE., NORWALK, CT. 06856

MINNESOTA RIVER AT CHASKA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

DEMAND LOAD ANALYSIS

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DATE:  1 10 91
TIME:  8 38 AM
--------------------------------------------------------------------------------
ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL, INTERPRETATION
AND APPLICATION BY A REGISTERED ENGINEER ONLY
--------------------------------------------------------------------------------
DAPPER ( DEMAND LOAD ANALYSIS   MINI/MICRO VERSION 3.4  LEVEL 2.1)
COPYRIGHT SKM SYSTEMS ANALYSIS, INC. 1983
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CHASKA

US ARMY CORP OF ENGINEERS - ST. PAUL, MINNESOTA

LOAD SUMMARY

LOAD SCHEDULE FOR 1 PRI UTIL — 13800. VOLTS LINE TO LINE
SOURCE OF PWR **** SOURCE BUS

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
BRANCH LOADS							
2 SEC	357.9	15.0	357.9	15.0	383.6	16.0	-80.6
TOTALS	357.9	15.0	357.9	15.0	383.6	16.0	-80.6

LOAD SCHEDULE FOR 2 SEC — 480. VOLTS LINE TO LINE
SOURCE OF PWR 1 PRI UTIL

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
BRANCH LOADS							
3 MCC	357.9	430.4	357.9	430.4	383.6	461.4	-80.6
TOTALS	357.9	430.4	357.9	430.4	383.6	461.4	-80.6

LOAD SCHEDULE FOR 3 MCC — 480. VOLTS LINE TO LINE
SOURCE OF PWR 2 SEC

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
MOTOR LOADS	235.1	282.8	235.1	282.8	235.1	282.8	-80.0
LARGEST MOTOR	103.1	124.0	103.1	124.0	128.9	155.0	-80.0
BRANCH LOADS							
4 HEATER	10.0	12.0	10.0	12.0	10.0	12.0	-90.0
5 PANEL	10.0	12.0	10.0	12.0	10.0	12.0	-90.0
TOTALS	357.9	430.4	357.9	430.4	383.6	461.4	-80.6

LOAD SCHEDULE FOR 4 HEATER — 480. VOLTS LINE TO LINE
SOURCE OF PWR 3 MCC

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	10.0	12.0	10.0	12.0	10.0	12.0	-90.0
TOTALS	10.0	12.0	10.0	12.0	10.0	12.0	-90.0

CHASKA

US ARMY CORP OF ENGINEERS - ST. PAUL, MINNESOTA

LOAD SUMMARY

LOAD SCHEDULE FOR 5 PANEL — 480. VOLTS LINE TO LINE
SOURCE OF PWR 3 MCC

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	10.0	12.0	10.0	12.0	10.0	12.0	-90.0
TOTALS	10.0	12.0	10.0	12.0	10.0	12.0	-90.0

CHASKA

US ARMY CORP OF ENGINEERS - ST. PAUL, MINNESOTA

SOURCE LOAD SUMMARY

LOAD BUS 1 PRI UTIL 13800. VOLTS LINE TO LINE

LOAD DESCRIPTION TYPE	UNITS	CONNECTED LOAD	DEMAND LOAD	DESIGN LOAD	POWER FACTOR %
GENERAL LOADS	KW	18.0	18.0	18.0	
	KVAR	-8.7	-8.7	-8.7	
	KVA	20.0	20.0	20.0	90.0 LAGGING
MOTOR LOADS	KW	188.1	188.1	188.1	
	KVAR	-141.1	-141.1	-141.1	
	KVA	235.1	235.1	235.1	80.0 LAGGING
LARGEST MOTOR	KW	82.5	82.5	103.1	
	KVAR	-61.9	-61.9	-77.3	
	KVA	103.1	103.1	128.9	80.0 LAGGING
TOTAL LOADS	KW	288.6	288.6	309.2	
	KVAR	-211.6	-211.6	-227.1	
	KVA	357.9	357.9	383.6	
	% PF	80.6 LAGGING	80.6 LAGGING	80.6 LAGGING	

CHASKA

US ARMY CORP OF ENGINEERS - ST. PAUL, MINNESOTA

LOAD DEMAND TABLE

LOAD DESCRIPTION	LOAD TYPE	FIRST KVA	DEMAND %	SECOND KVA	DEMAND %	THIRD KVA	DEMAND %	% PF	DESIGN FACT
GENERAL LOADS	K	100.	100.	ALL	50.	ALL	50.	-90.0	1.00
LIGHTING	K	ALL	100.	ALL	100.	ALL	100.	-95.0	1.25
RECEPTACLES	Z	10.	100.	ALL	50.	ALL	50.	-95.0	1.00
OFFICE EQUIPMENT	Z	ALL	100.	ALL	100.	ALL	100.	-85.0	1.00
HEATING	Z	ALL	100.	ALL	100.	ALL	100.	100.0	1.25
STANDBY LOADS	K	ALL	100.	ALL	100.	ALL	100.	-85.0	1.25
CAPACITOR BANK	Z	ALL	100.	ALL	100.	ALL	100.	.0	1.35
SYNC. MOTOR	K	ALL	100.	ALL	100.	ALL	100.	100.0	1.25
MOTOR LOADS	K	ALL	100.	ALL	100.	ALL	100.	-80.0	1.00
LARGEST MOTOR	K	ALL	100.	ALL	100.	ALL	100.	-80.0	1.25

NOTES: LOAD TYPE 10 PROVIDES TRANSFER FUNCTION TO LOAD TYPE 9
DEMAND AND DESIGN FACTORS APPLIED AT EACH LOAD BUS
AND ALL LOAD TOTALS ARE POWER FACTOR CORRECTED

MINNESOTA RIVER AT CHASKA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

SHORT CIRCUIT ANALYSIS

CHASKA

US ARMY CORP OF ENGINEERS - ST. PAUL, MINNESOTA

DATE: 1 10 91
TIME: 8 41 AM

ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL
INTERPRETATION AND APPLICATION BY A REGISTERED
ENGINEER ONLY

DAPPER (SHORT CIRCUIT PROGRAM MINI/MICRO VERSION 3.4 LEVEL 2.1)

DATE: 1 10 91 TIME: 8 41 AM
CHASKA

US ARMY CORP OF ENGINEERS - ST. PAUL, MINNESOTA

C O N T R I B U T I O N   D A T A

CONTRIBUTION FROM NAME	NO	NAME	VOLTAGE L-L	BASE MVA	XD"(PU)	X/R
CITY CHASK	1	PRI UTIL	13800.	3P-KA:	37.653	30.0
ANSI TYPE: UTILITY				1P-KA:		
POS SEQUENCE IMPEDANCE					.00370 + J	.11105 PER UNIT
PUMP 1	3	MCC	480.	.100	.25000	15.0
ANSI TYPE: IND. MOTOR HP:			100.	RPM: 1800.		
POS SEQUENCE IMPEDANCE					16.66667 + J	250.00000 PER UNIT
PUMP 2	3	MCC	480.	.100	.25000	15.0
ANSI TYPE: IND. MOTOR HP:			100.	RPM: 1800.		
POS SEQUENCE IMPEDANCE					16.66667 + J	250.00000 PER UNIT
PUMP 3	3	MCC	480.	.100	.25000	15.0
ANSI TYPE: IND. MOTOR HP:			100.	RPM: 1800.		
POS SEQUENCE IMPEDANCE					16.66667 + J	250.00000 PER UNIT

CHASKA

US ARMY CORP OF ENGINEERS - ST. PAUL, MINNESOTA

F E E D E R D A T A

FEEDER FROM NO	FEEDER FROM NAME		FEEDER TO NO NAME	QTY /PH	VOLTS L-L	LENGTH FEET	FEEDER SIZE	FEEDER TYPE	DESCRIPTION DUCT	DESCRIPTION INSUL
2	SEC		3 MCC	2	480.	75.	500	C	M	THWN
	POS	SEQ Z	.0294 + J	.0466 OHMS/M FEET			.47852 + J		.75846 PU	
3	MCC		4 HEATER	1	480.	30.	12	C	M	THWN
	POS	SEQ Z	1.8700 + J	.0910 OHMS/M FEET			24.34896 + J		1.18490 PU	
3	MCC		5 PANEL	1	480.	30.	14	C	N	THWN
	POS	SEQ Z	2.9700 + J	.0961 OHMS/M FEET			38.67188 + J		1.25130 PU	

US ARMY CORP OF ENGINEERS - ST. PAUL, MINNESOTA

TRANSFORMER DATA

PRIMARY RECORD NO	NAME	CONN	VOLTS L-L	PRI FLA	* SECONDARY RECORD NO	NAME	CONN	VOLTS L-L	SEC FLA	NOMINAL KVA
1	PRI UTIL	Y	13800.	21.	2	SEC	YG	480.	601.	500.0

POS SEQ Z 1.0000 + J 4.8989 PERCENT 2.00000 + J 9.79780 PER UNIT

CHASKA

US ARMY CORP OF ENGINEERS - ST. PAUL, MINNESOTA

THREE PHASE FAULT REPORT

1 PRI UTIL	FAULT: 37698.	RMS SYM AMPS,	901060. KVA	X/R: 29.945
	VOLTAGE: 13800.	IMPEDANCE TO GND=	.00705 + J	.21123 OHMS
	CONTRIBUTIONS:	CITY CHASK	37653. AMPS	X/R: 30.000
		2 SEC	44. AMPS	X/R: 11.686
2 SEC	FAULT: 13314.	RMS SYM AMPS,	11069. KVA	X/R: 5.318
	VOLTAGE: 480.	IMPEDANCE TO GND=	.00385 + J	.02046 OHMS
	CONTRIBUTIONS:	1 PRI UTIL	11898. AMPS	X/R: 4.945
		3 MCC	1427. AMPS	X/R: 13.936
3 MCC	FAULT: 12406.	RMS SYM AMPS,	10314. KVA	X/R: 4.694
	VOLTAGE: 480.	IMPEDANCE TO GND=	.00465 + J	.02185 OHMS
	CONTRIBUTIONS:	PUMP 1	480. AMPS	X/R: 15.000
		PUMP 2	480. AMPS	X/R: 15.000
		PUMP 3	480. AMPS	X/R: 15.000
		2 SEC	10982. AMPS	X/R: 4.297
4 HEATER	FAULT: 4229.	RMS SYM AMPS,	3516. KVA	X/R: .405
	VOLTAGE: 480.	IMPEDANCE TO GND=	.06075 + J	.02458 OHMS
	CONTRIBUTIONS:	3 MCC	4229. AMPS	X/R: .405
5 PANEL	FAULT: 2858.	RMS SYM AMPS,	2376. KVA	X/R: .264
	VOLTAGE: 480.	IMPEDANCE TO GND=	.09375 + J	.02473 OHMS
	CONTRIBUTIONS:	3 MCC	2858. AMPS	X/R: .264

CHASKA

US ARMY CORP OF ENGINEERS - ST. PAUL, MINNESOTA

F A U L T S T U D Y S U M M A R Y

BUS RECORD NO	NAME	VOLTAGE L-L	AVAILABLE FAULT DUTIES 3 PHASE	LINE/GRND
1	PRI UTIL	13800.	37698.	
2	SEC	480.	13314.	
3	MCC	480.	12406.	
4	HEATER	480.	4229.	
5	PANEL	480.	2858.	

5 BUSES, 8 BRANCHES, 4 CONTRIBUTIONS
*** SHORT CIRCUIT STUDY COMPLETE ***

APPENDIX F

CONSTRUCTIBILITY

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX F

CONSTRUCTIBILITY

TABLE OF CONTENTS

Item	Page	Paragraph
Introduction	F-1	1
Major Construction Activities	F-1	2
Construction Scheduling Considerations	F-1	3
Water Control		
Ground Water	F-2	4
River Water	F-2	5
Utility Modification Schedule	F-2	6
Traffic Considerations	F-3	7,8
Construction Materials	F-3	9
Disposal Areas	F-3	10
Plates F-1 and F-2		

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX F

CONSTRUCTIBILITY

INTRODUCTION

1. This appendix presents the construction aspects of the proposed flood control improvements on the Minnesota River at Chaska Minnesota. Information is presented on major construction activities, scheduling, water control, utility modifications, traffic considerations, construction material, and disposal areas.

MAJOR CONSTRUCTION ACTIVITIES

2. Stage 4 of the flood control project consists primarily of a levee that protects Chaska from flooding of the Minnesota River and related interior drainage facilities that consist of a storm water pumping station, interceptor, and outlet pipes with gatewells. The work includes the following major construction activities:

a. Construction of about 271,000 CY of impervious levee.
b. Construction of about 414,000 LF of wick drains.
c. Construction of about 8,200 CY of riprap and bedding.
d. Construction of one 18,000 gpm storm water pump station.
e. Construction of about 4,600 LF of RCP between 18" and 72".
f. Construction of about 14 manholes and 16 inlets.
g. Construction of about 36 relief wells with 12" RCP outlet.
h. Construction of two gatewells.

These activities can be accomplished using ordinary construction equipment and methods.

CONSTRUCTION SCHEDULING CONSIDERATIONS

3. The construction of this project is scheduled to start in January 1993 and be completed in August 1994. The construction contractor will be responsible for the construction schedule and be required to prepare and receive approval on a network analysis system that shows his proposed construction schedule. Construction items that will require special consideration include:

a. Levee between station 0+00 and 30+00.
b. New sanitary sewer between stations 32+00 and 71+00.
c. Levee between stations 60+00 and 70+00.
d. Outlet ends of Outlets B and C.

All operations affected by the Minnesota River shall be scheduled to take

advantage of favorable river stages. Also the existing drainage facilities shall not be removed or otherwise rendered nonfunctional prior to operation of the permanent project facilities or installation of approved temporary facilities.

WATER CONTROL

GROUND WATER

4. It is anticipated that some of the proposed interceptor pipe will lie below the normal ground water table. Sump pumps or well points will be used to lower the ground water. That portion of Outlet B and C that is riverward of the Gatewells is about 10 to 15 feet below the normal ground water table. It is expected that dewatering wells will be required to lower the ground water level for this portion of the gatewells and outlet construction. Because of the pervious nature of the subsurface soils the normal ground water level is influenced by Minnesota River levels and more extensive dewatering systems will be necessary during above normal river stages.

RIVER WATER

5. The outlet ends of Outlet B and C lie below the normal low Minnesota River level and will require construction of cofferdams to complete.

UTILITY MODIFICATION SCHEDULE

6. Table F-1 summarizes the required telephone, electric, gas, sewer, and water utility modifications required.

TABLE F-1

UTILITY MODIFICATION SCHEDULE

STATION	UTILITY	SUMMARY
48+65,49+50,51+50, 53+80,57+40,57+45, 57+50,57+55,61+30, 63+60,63+70,65+50,	Utility pole	Remove and replace
29+10	NSP 69 KV Trans. line	Modify guy wire
50+50	Under grd teleph	Modify
57+50,65+50	Overhead teleph	Modify
48+10	San.lift station	Construct
48+00,52+00,55+00, 59+50	Hydrants	Relocate
48+10 to 71+20	12" sanitary	Construct
34+00 to 48+10	8" san. force	Construct

TRAFFIC CONSIDERATIONS

7. Access to the project between station 0+00 and 32+00 will be by an existing private farm road at station 7+50. Access to the project between stations 32+00 and 77+00 will be by existing city streets. The contractor will be required to maintain local traffic at station 7+50 for farm operations, at station 31+00 through 34+50 for pedestrians, at station 34+60 for farm operations, and at station 60+00 for boat docking access. Closure of Minnesota Highway 41 at station 56+00 will not be allowed.

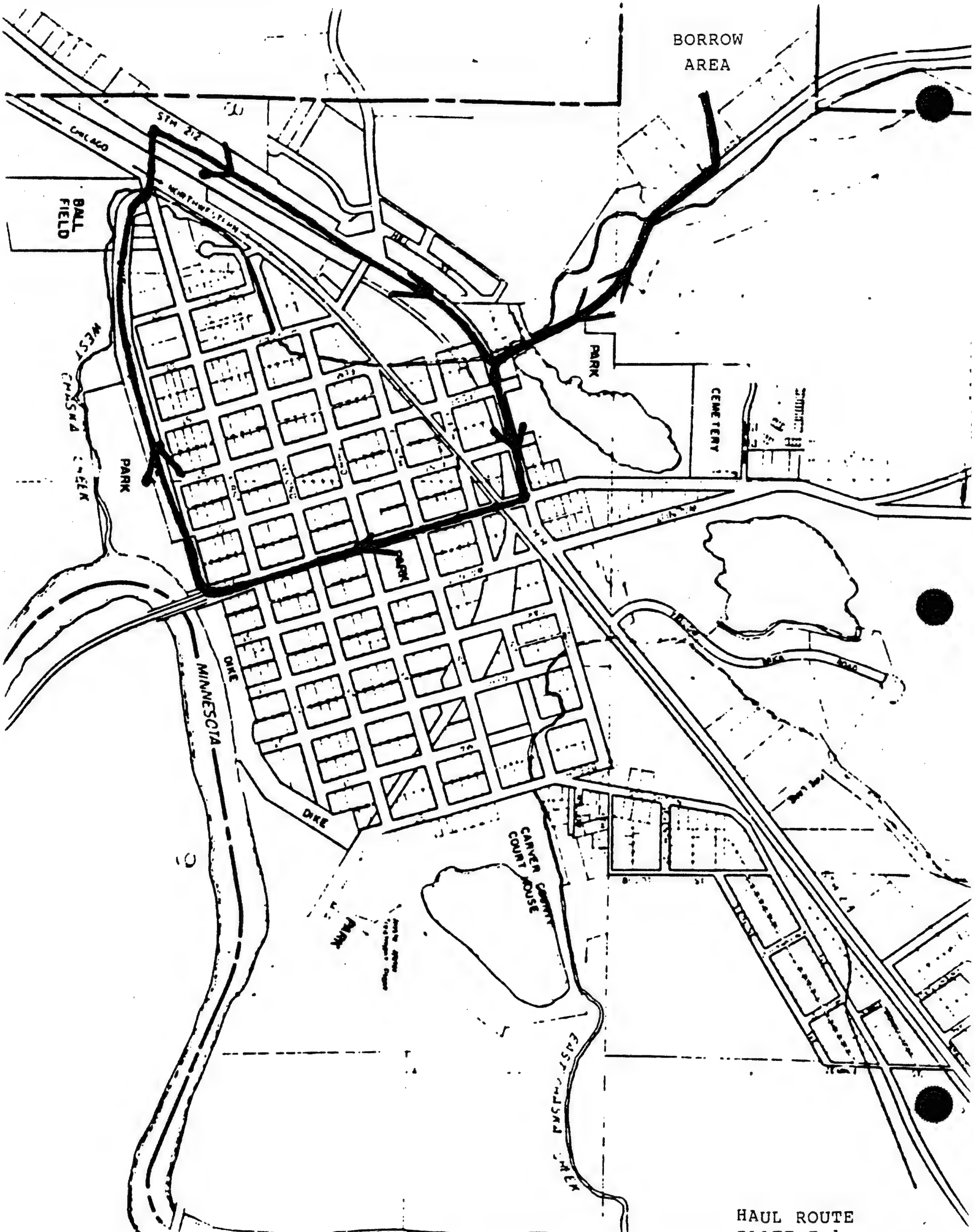
8. When continuous haul operations result in hazard to traffic on streets and highways, the contractor shall erect warning signs and provide flagging services as necessary to safeguard the public. Haul roads shall be maintained by the contractor and kept free of debris. The designated haul roads from the impervious borrow area are shown on Plates F-1 and F-2. In general these haul routes shall be used for hauling all materials to and from the construction site.

CONSTRUCTION MATERIALS

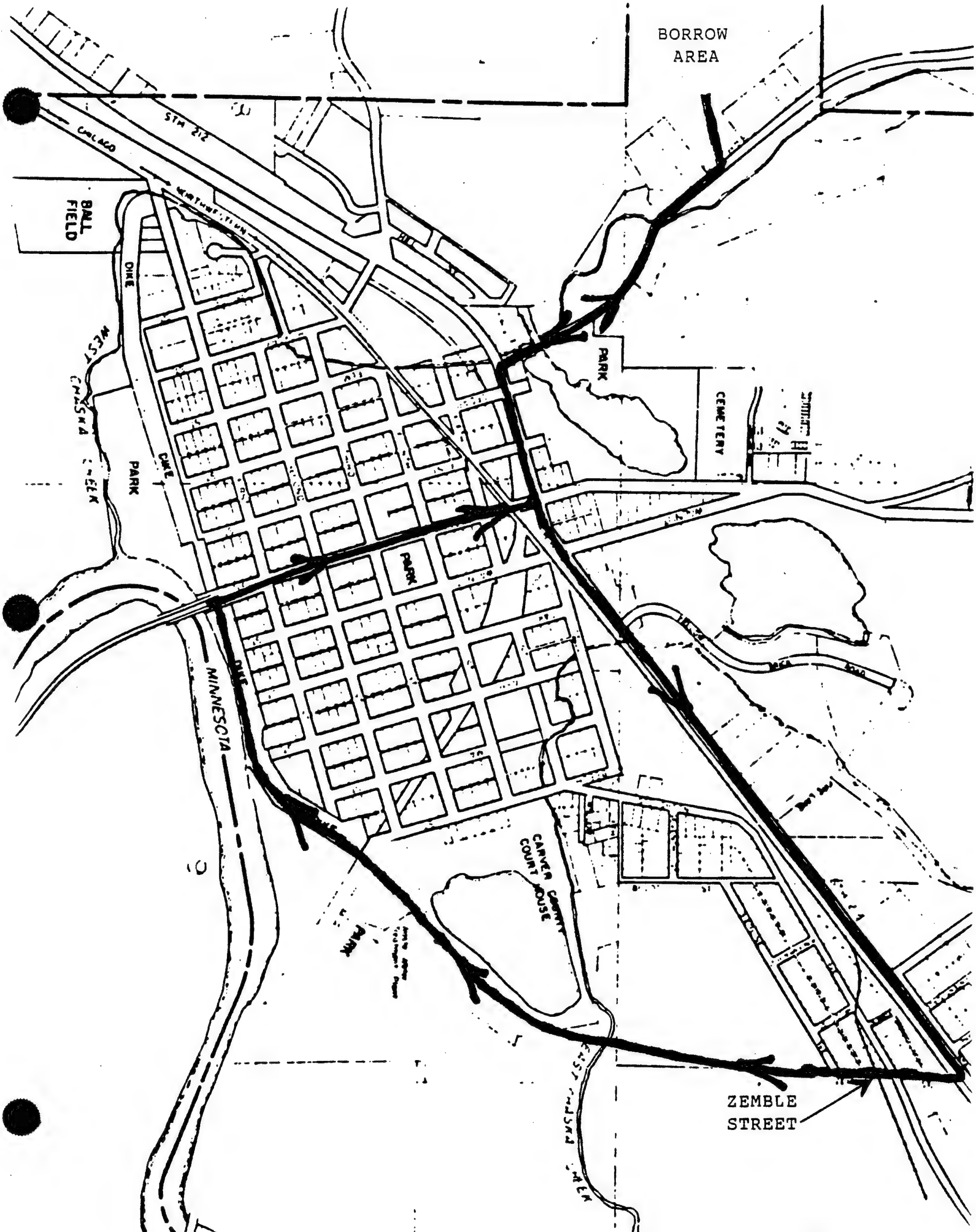
9. Adequate supplies of riprap, bedding, concrete aggregate and impervious levee fill are available within a reasonable haul distance of Chaska. Additional information on construction materials is presented in Appendix C.

DISPOSAL AREA

10. A disposal area for debris and waste is available at the Louisville Landfill, located approximately 3 miles southwest of the project site. This area is a locally operated landfill and is available with charge to the contractor. The contractor will be encouraged to dispose of timber off site for some useful purpose.



HAUL ROUTE
PLATE F-1



HAUL ROUTE
PLATE E-2

APPENDIX G

COST ESTIMATE

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX G

COST ESTIMATE

TABLE OF CONTENTS

Item	Page
Narrative	G-1
Total Project Cost Summaries	G-3
Lands and Damages	G-4
Relocations	G-5
Levees and Floodwalls	G-7
Pumping Plant	G-16
Recreation	G-19
Planning Engineering and Design	G-21
Construction Management	G-23
Construction Progress Chart	G-24

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 4 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PRPOJECT

APPENDIX G

NARRATIVE REPORT
FOR

CHASKA STAGE 4 DM

COST ESTIMATE

1. Description of Project. The flood control project at Chaska, Minnesota is divided into four stages. This Design Memorandum (DM) presents the design of planning for Stage 4 which in general consists of a levee that protects Chaska from flooding from the Minnesota River. Work for this stage consists of upgrading approximately 4,200-feet of existing levee, 2,800-feet of new levee, one 18,000 GPM pump station, 2 outlets with gatewells, interceptor pipe with manholes and inlets, relief wells, wick drains and sanitary sewer with lift station.

2. Proposed construction methods for major work items.

a. Impervious Fill. Impervious fill will be loaded at borrow pit and hauled by trucks via established haul routes. It is assumed in this estimate that trucks will have to drive on existing levees, dozers, sheepsfoot compactors and water trucks will be used. Impervious fill material price is a separate line item, since this is a non-federal cost.

b. Wick Drains. Wick drains will be installed to allow water to move from soil to consolidate soil in a rapid manner. The wick drains will be constructed in the new levee area. A special fabricated mandrel is attached to a hydraulic excavator for installation. Production rates, material costs and crew size were developed by consultation with manufactures representative.

c. Outlets. Two outlets will be constructed. They consist of Outlet B upstream of the Highway 41 Bridge. Outlet B consists of a 72-inch and twin 48-inch RCP with gatewell, sluice gate and scour hole. Work consists of cast-in-place concrete, 72"x72" sluice gate, sheetpile, excavation and backfill. The outlet will be constructed using a crane for placing concrete, sluice gate, sheetpile, RCP and other items of work.

Outlet C will be constructed near Oak Street. This will consist of a 66-inch and twin 48-inch RCP with gatewell, sluice gate and scour hole. Other work consists of excavation, cast-in-place concrete, formwork, and backfill. The outlet will be constructed using a crane for placing concrete, sluice gate, sheetpile, RCP and other items of work.

d. Pump Station. An 18,000 GPM pumping station with three 6,000 GPM pumps will be constructed near Oak Street. Work associated with the pump station is sitework, cast-in-place concrete, trash rack, structural steel, sluice gate, electrical and mechanical. The pump station will be constructed by using a crane and other equipment necessary for the superstructure and parking area.

e. Reinforced Concrete Pipe. Reinforced concrete pipe will be installed between the manholes. 18 inch through 72 inch diameter RCP will be constructed. Excavation was based on a 1-on-2 sideslopes so unit prices are somewhat increased. Reinforced concrete pipe will be constructed with a hydraulic excavator and a crane will be used in addition to the excavator for placing the larger pieces of pipe.

f. Relief Wells. Relief wells will be installed at 36 various locations. The relief wells are 30-inch diameter with plastic screens and 48-inch diameter manholes. Material prices, production rates and equipment are based on quotes from a local well driller contractor.

g. Dewatering. Dewatering will include using wellpoints, sumping, deep wells and sheetpile. Dewatering will be needed for various items of work including the inspection trench, outlets B and C, sewer removal and replacement and miscellaneous structures below the water table.

3. Unit Cost Analysis. The unit costs shown were derived by MCACES composer, work analysis and from production rates obtained from specialty contractors.

4. Planning, Engineering and Design Costs. These costs were obtained by Project Management and were based on actual man-hour estimates derived by all affected functional units.

5. Construction Management Costs. This cost was obtained by the Construction Branch.

6. Contingency Analysis. Contingencies shown on the summary sheets reflect uncertainties in design (quantities), unit pricing and pure unknowns. The range for the contingency component for quantities varied between zero and forty percent and for unit costs varied between zero and ten percent. The pure unknown component was given a constant five percent value and was applied to all work items.

TOTAL - STAGE 4 **** TOTAL PROJECT COST SUMMARIES ****

PROJECT:CHASKA, STAGE 4 (FDM ESTIMATE)
LOCATION: CHASKA, MINNESOTA
DATE PREPARED: 4/15/91

PREPARED BY: CENCS-ED-C
REVIEWED AND APPROVED BY: Allen J. Green, CHIEF, ED-C

ACCOUNT NUMBER	ITEM DESCRIPTION	ESTIMATED COST($) (EPD)	CONTINGENCY AMOUNT($)	%	TOTAL EST COST (EPD)	OMB INFLATION TO OCT-91 %	EPC OCT-91	MID POINT OF FEATURE	OMB (%) INFLATION (+/-)	INFLATED COST AMOUNT ($)	INFLATED CONTG. AMT. ($)	FULLY FUNDED COST
02---	RELOCATIONS	451,000	84,000	19%	535,000	1.90%	545,000	Oct-93	8.68%	499,000	93,000	592,000
11---	LEVEES AND FLOODWALLS	4,699,000	856,000	18%	5,555,000	1.90%	5,661,000	Oct-93	8.68%	5,204,000	948,000	6,152,000
13---	PUMPING PLANT	529,000	106,000	20%	635,000	1.90%	647,000	Oct-93	8.68%	586,000	117,000	703,000
14---	RECREATION FACILITIES	86,000	17,000	20%	103,000	1.90%	105,000	Oct-93	8.68%	95,000	19,000	114,000
	TOTAL CONSTRUCTION COSTS =====>	5,765,000	1,063,000		6,828,000		6,958,000			6,384,000	1,177,000	7,561,000
01---	LANDS AND DAMAGES	1,565,000	299,000	19%	1,864,000	1.90%	1,899,000	Sep-92	4.20%	1,662,000	317,000	1,979,000
30---	PLANNING, ENGINEERING AND DESIGN	1,607,000	126,000	8%	1,733,000	2.36%	1,774,000	Jan-92	3.00%	1,694,000	133,000	1,827,000
31---	CONSTRUCTION MANAGEMENT	375,000	0	0%	375,000	2.36%	384,000	Oct-93	17.36%	450,000	0	450,000
	TOTAL PROJECT COSTS =====>	9,312,000	1,488,000		10,800,000		11,015,000			10,190,000	1,627,000	11,817,000

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
01.-.-.-	LANDS AND DAMAGES							
01.B.-.-	POST-AUTHORIZATION PLANNING	LS	1	600	600	100	16.7%	1,2,4
01.D.-.-	ACQUISITION:							
01.D.-.-	ACQUISITION (LOCAL SPONSOR)	OSP	45	611	27,500	4,100	14.9%	1,2,4
01.D.-.-	ACQUISITION (FED.REVIEW/ASSISTANCE)	OSP	45	287	12,900	1,900	14.7%	1,2,4
01.E.-.-	CONDEMNATION (POST-DT FILING):							
01.E.-.-	CONDEMNATION (POST-DT)-LOCAL SPONSOR	TRT	0	0				
01.E.0.E	FEDERAL REVIEW OF DOCUMENTS	TRT	0	0				
01.F.-.-	APPRAISALS:							
01.F.2.H	PREPARE APPRAISALS-LOCAL SPONSOR	OSP	45	500	22,500	3,400	15.1%	1,2,4
01.F.2.J	FEDERAL REVIEW OF APPRAISALS	OSP	45	260	11,700	1,800	15.4%	1,2,4
01.H.-.-	RELOCATIONS:							
01.H.1.-	P.L.91-646 RELOCATIONS-LOCAL SPONSOR	OSP	8	625	5,000	800	16.0%	1,2,4
01.H.1.E	FEDERAL REVIEW OF DOCUMENTS	OSP	8	375	3,000	500	16.7%	1,2,4
01.M.-.-	REAL ESTATE RECEIPTS/PAYMENTS:							
01.M.3.-	LAND PAYMENTS	LS	1	1,293,000	1,293,000	258,600	20.0%	1,2,4
01.M.4.-	P.L.91-646 RELOCATIONS	LS	1	188,250	188,300	28,200	15.0%	1,2,4
	Total Estimated Cost				1,565,000			
	Contingencies			19.11%		299,000		
	Total Estimated Cost and Contingencies					1,864,000		

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
02.-.-.-	RELOCATIONS							
02.1.A.-	MOB.& DEMOB.	JOB	1	16,550.00	16,550	4,000	24.2%	1,2,3
02.3.A.A	MOB & DEMOB.	JOB	1	16,550.00	16,550	4,000	20.0%	1,2,3
02.1.2.-	NORTH RAMP	JOB	1	56,975.00	56,975	11,394	20.0%	1,2,3
02.1.2.B	AGGREGATE BASE	CY	165	11.40	1,881	376	20.0%	1,2,3
02.1.2.B	ROAD FILL -IMPERVIOUS	CY	9,170	4.56	41,815	8,363	20.0%	1,2,3
02.1.2.B	LOADING FROM PIT	CY	9,170	0.57	5,227	1,045	20.0%	1,2,3
02.1.2.B	HAULING FROM PIT	CY	11,004	0.59	6,492	1,298	20.0%	1,2,3
02.1.2.B	TOPSOIL	CY	350	1.93	676	135	20.0%	1,2,3
02.1.2.B	SEEDING	ACR	1	680.00	884	177	20.0%	1,2,3
02.1.2.-	CEDAR STREET RAMP	EA	1	34,721.00	34,721	6,945	20.0%	1,2,3
02.1.2.B	AGGREGATE BASE	CY	244	11.40	2,782	556	20.0%	1,2,3
02.1.2.B	ROAD FILL - IMPERVIOUS	CY	5,400	4.56	24,624	4,925	20.0%	1,2,3
02.1.2.B	LOADING FROM PIT	CY	5,400	0.57	3,078	616	20.0%	1,2,3
02.1.2.B	HAULING FROM PIT	CY	5,400	0.71	3,834	767	20.0%	1,2,3
02.1.2.B	TOPSOIL	CY	93	1.93	179	36	20.1%	1,2,3
02.1.2.B	SEEDING	ACR	0	1,120.00	224	45	20.1%	1,2,3
02.1.2.-	PEDESTRIAN RAMP	JOB	1	27,996.00	27,996	5,599	20.0%	1,2,3
02.1.2.B	AGGREGATE BASE	CY	39	11.40	445	89	20.0%	1,2,3
02.1.2.B	FILL - IMPERVIOUS	CY	3,200	4.40	14,080	2,816	20.0%	1,2,3
02.1.2.B	LOADING FROM PIT	CY	3,200	0.57	1,824	365	20.0%	1,2,3
02.1.2.B	HAULING FROM PIT	CY	3,200	0.68	2,176	435	20.0%	1,2,3
02.1.2.B	RAILING	LF	210	45.10	9,471	1,894	20.0%	1,2,3
02.1.2.-	BEECH STREET RAMP	JOB	1	12,098.00	12,098	2,420	20.0%	1,2,3
02.1.2.B	AGGREGATE BASE COURSE	CY	70	11.40	798	160	20.1%	1,2,3
02.1.2.B	FILL IMPERVIOUS	CY	2,000	4.40	8,800	1,760	20.0%	1,2,3
02.1.2.B	LOAD FROM PIT	CY	2,000	0.57	1,140	228	20.0%	1,2,3
02.1.2.B	HAUL FROM PIT	CY	2,000	0.68	1,360	272	20.0%	1,2,3
02.1.2 -	REMOVE PEDESTRAIN BDGE.	SF	300	3.89	1,167	233	20.0%	1,2,3
02.3.2.B	REMOVE WOOD RAIL	LF	40	1.75	70	14	20.0%	1,2,3
02.3.2.B	REMOVE PLANKING	SF	300	0.94	282	56	19.9%	1,2,3
02.3.2.B	REMOVE SUBSTRUCTURE	JOB	1	815.00	815	163	20.0%	1,2,3
02.3.2.-	WATER LINES	JOB	1	1,965.00	1,965	393	20.0%	1,2,3
02.3.2.Q	RELOCATE HYDRANT	EA	5	393.00	1,965	393	20.0%	1,2,3
02.3.2.-	UTILITY MODIFICATIONS	JOB	1	24,310.00	24,310	12,155	50.0%	1,2,3
02.3.2.R	REMOVE OVERHEAD LINES	LF	100	37.90	3,790	1,895	50.0%	1,2,3

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
02.3.2.R	REMOVE UTILITY POLE	EA	12	309.00	3,708	1,854	50.0%	1,2,3
02.3.2.R	REPLACE UTILITY POLES	EA	12	425.00	5,100	2,550	50.0%	1,2,3
02.3.2.R	REMOVE UTILITY POLES	EA	4	309.00	1,236	618	50.0%	1,2,3
02.3.2.R	REMOVE UNDERGROUND TELE	LF	50	75.80	3,790	1,895	50.0%	1,2,3
02.3.2.Q	REMOVE HYDRANTS	EA	5	124.00	620	310	50.0%	1,2,3
02.3.2.R	REPLACE HYDRANTS	EA	5	31.60	158	79	50.0%	1,2,3
02.3.2.Q	FILL SANITARY PIPE	CY	85	69.50	5,908	2,954	50.0%	1,2,3
02.3.2 - LIFT STATION		JOB	1	44,200.00	44,200	8,840	20.0%	1,2,3
02.3.2.B	LIFT STATION	EA	1	44,200.00	44,200	8,840	20.0%	1,2,3
02.3.2 - INSTALL 12" SANITARY		LF	2,260	63.37	143,212	19,497	13.6%	1,2,3
02.3.2.B	BACKFILL	CY	16,651	5.01	83,422	8,342	10.0%	1,2,3
02.3.2.Q	12" SANITARY PIPE	LF	2,260	22.90	51,754	10,351	20.0%	1,2,3
02.3.2.B	EXCAVATION	CY	16,741	0.48	8,036	804	10.0%	1,2,3
02.3.2 - INSTALL 8" SANITARY		LF	1,490	47.36	70,563	9,456	13.4%	1,2,3
02.3.2.B	BACKFILL	CY	11,007	3.75	41,276	4,128	10.0%	1,2,3
02.3.2.Q	8" PIPE	LF	1,490	16.10	23,989	4,798	20.0%	1,2,3
02.3.2.B	EXCAVATION	CY	11,037	0.48	5,298	530	10.0%	1,2,3
02.3.2.- MANHOLES		JOB	1	17,500.00	17,500	3,094	17.7%	
02.3.2.B	MANHOLE NO.1	JOB	1	2,970.00	2,970	523	17.6%	1,2,3
02.3.2.B	MANHOLE NO.2	JOB	1	3,130.00	3,130	548	17.5%	1,2,3
02.3.2.B	MANHOLE NO.3	JOB	1	4,290.00	4,290	716	16.7%	1,2,3
02.3.2.B	MANHOLE NO.4	JOB	1	2,410.00	2,410	441	18.3%	1,2,3
02.2.2.B	MANHOLE NO.5	JOB	1	1,780.00	1,780	322	18.1%	1,2,3
02.3.2.B	MANHOLE NO.6	JOB	1	1,570.00	1,570	290	18.5%	1,2,3
02.3.2.B	MANHOLE NO.7	JOB	1	1,350.00	1,350	254	18.8%	1,2,3
	Total Estimated Cost				451,257			
	Contingencies			18.62%		84,026		
	Total Estimated Cost and Contingencies					535,283		

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
11.-.-.-	LEVEES AND FLOODWALLS							
11.0.A.-	MOB/DEMOB & PREP	JOB	1	44,200.00	44,200	8,840	20.0%	1,2,3
11.0.A.B	MOB./DEMOB. AND PREP.	JOB	1	44,200.00	44,200	8,840	20.0%	1,2,3
11.0.B.-	DEWATERING	JOB	1	379,500.00	379,500	56,925	15.0%	1,2,3
11.0.B.B	DEWATERING	JOB	1	379,500.00	379,500	56,925	15.0%	1,2,3
11.0.1.-	CLEAR AND GRUB	ACR	27	2,350.00	63,450	12,690	20.0%	1,2,3
11.0.1.B	CLEAR AND GRUB	ACR	27	2,350.00	63,450	12,690	20.0%	1,2,3
11.0.1.-	COMMON EXCAVATION	CY	16,632	1.60	26,611	5,322	20.0%	1,2,3
11.0.1.B	COMMON EXCAVATION	CY	16,632	1.60	26,611	5,322	20.0%	1,2,3
11.0.1.-	IMPERVIOUS FILL	CY	271,402	2.80	759,926	151,985	20.0%	1,2,3
11.0.1.B	IMPERVIOUS FILL	CY	271,402	2.80	759,926	151,985	20.0%	1,2,3
11.0.1.-	IMPERVIOUS FILL NON-FED	CY	325,682	0.45	146,557	29,311	20.0%	1,2,3
11.0.1.B	IMPERVIOUS FILL NON-FED	CY	325,682	0.45	146,557	29,311	20.0%	1,2,3
11.0.1.-	STRIPPING	CY	27,470	2.37	65,104	13,021	20.0%	1,2,3
11.0.1.B	STRIPPING	CY	27,470	2.37	65,104	13,021	20.0%	1,2,3
11.0.1.-	INSPECTION TRENCH	LF	7,115	4.70	33,442	6,688	20.0%	1,2,3
11.0.1.B	INSPECTION TRENCH	CY	18,579	1.80	33,442	6,688	20.0%	1,2,3
11.0.1.-	PERVIOUS FILL	CY	20,200	7.62	153,924	30,785	20.0%	1,2,3
11.0.1.B	PERVIOUS FILL	CY	20,200	7.62	153,924	30,785	20.0%	1,2,3
11.0.1.-	RANDOM FILL	CY	1,835	2.84	5,211	1,042	20.0%	1,2,3
11.0.1.B	RANDOM FILL	CY	1,835	2.84	5,211	1,042	20.0%	1,2,3
11.0.1.-	GEOTEXTILE	SY	10,933	1.09	11,917	2,383	20.0%	1,2,3
11.0.1.B	GEOTEXTILE	SY	10,933	1.09	11,917	2,383	20.0%	1,2,3
11.0.1.-	BEDDING	CY	2,733	35.60	97,295	19,459	20.0%	1,2,3
11.0.1.B	BEDDING	CY	2,733	35.60	97,295	19,459	20.0%	1,2,3
11.0.1.-	RIPRAP	CY	5,467	33.60	183,691	36,738	20.0%	1,2,3

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
11.0.1.B	RIPRAP	CY	5,467	33.60	183,691	36,738	20.0%	1,2,3
11.0.1.-	PERVIOUS BERM FILL	CY	18,700	5.94	111,078	22,216	20.0%	1,2,3
11.0.1.B	PERVIOUS FILL BERM	CY	18,700	5.94	111,078	22,216	20.0%	1,2,3
11.0.1.-	PERVIOUS FILL MN. RIVER	CY	4,975	12.20	60,695	12,139	20.0%	1,2,3
11.0.1.B	PERVIOUS FILL	CY	4,975	12.20	60,695	12,139	20.0%	1,2,3
11.0.1.-	TOPSOIL	CY	16,581	3.33	55,215	11,043	20.0%	1,2,3
11.0.1.B	TOPSOIL	CY	16,581	3.33	55,215	11,043	20.0%	1,2,3
11.0.1.-	SEEDING	ACR	30	1,870.00	56,100	11,220	20.0%	1,2,3
11.0.1.B	SEEDING	ACR	30	1,870.00	56,100	11,220	20.0%	1,2,3
11.0.1.-	EAST CREEK, TIE IN	JOB	1	2,900.00	2,900	580	20.0%	1,2,3
11.0.1.B	EXCAVATION AND EMBANKMENT	JOB	1	2,900.00	2,900	580	20.0%	1,2,3
11.0.1-	STRUCTURAL REMOVALS	JOB	1	103,826.00	103,826	25,958	25.0%	1,2,3
11.0.1.B	REMOVE PUMP STATION	EA	2	9,510.00	19,020	4,755	25.0%	1,2,3
11.0.1.B	REMOVE HOUSE FOUNDS.	EA	6	2,290.00	13,740	3,435	25.0%	1,2,3
11.0.1.B	REMOVE GARAGE SLABS	SY	320	3.57	1,142	286	25.0%	1,2,3
11.0.1.B	REMOVE FENCE	LF	50	2.49	125	31	25.0%	1,2,3
11.0.1.B	BITUMINOUS REMOVALS	SY	2,430	3.57	8,675	2,169	25.0%	1,2,3
11.0.1.B	HWY. 41 BRIDGE ABUT.	CY	35	94.10	3,294	824	25.0%	1,2,3
11.0.1.B	REMOVE SANITARY MANHOLE	EA	11	4,260.00	46,860	11,715	25.0%	1,2,3
11.0.1.B	REMOVE 10" PIPE 28+80	LF	50	5.88	294	74	25.0%	1,2,3
11.0.1.B	REMOVE 18"	LF	130	5.36	697	174	25.0%	1,2,3
11.0.1.B	PLUG SANITARY SEWER 8"	EA	7	375.00	2,625	656	25.0%	1,2,3
11.0.1.B	PLUG 4" CIP WATERLINE	EA	6	58.40	350	88	25.0%	1,2,3
11.0.1.B	REMOVE GATE VALVE	EA	1	76.70	77	19	25.0%	1,2,3
11.0.1.B	REMOVE 21" DIP 31+90	LF	80	7.51	601	150	25.0%	1,2,3
11.0.1.B	PLUG 2" STEEL GASMAIN	EA	1	56.40	56	14	25.0%	1,2,3
11.0.1.B	REMOVE STORM SEWERS	JOB	1	6,270.00	6,270	1,568	25.0%	1,2,3
11.0.C.-	GUARD POSTS	EA	12	59.33	712	142	19.9%	1,2,3
11.0.C.B	GUARD POSTS	EA	12	59.33	712	142	19.9%	1,2,3
11.0.C.-	TRAFFIC CONTROL	JOB	1	90,900.00	90,900	13,635	15.0%	1,2,3
11.0.C.B	TRAFFIC CONTROL	JOB	1	90,900.00	90,900	13,635	15.0%	1,2,3
11.0.C.-	AGGREGATE BASE COURSE	CY	1,234	12.00	14,808	2,962	20.0%	1,2,3
11.0.C.B	AGGR. BASE 0+00-9+30	CY	172	12.00	2,064	413	20.0%	1,2,3
11.0.C.B	AGGR. BASE 13+20-55+05	CY	775	12.00	9,300	1,860	20.0%	1,2,3

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
11.0.C.B	AGGR. BASE 55+65-71+17	CY	287	12.00	3,444	689	20.0%	1,2,3
11.0.G.B	WICK DRAINS	LF	413,714	0.572	236,504	35,476	15.0%	1,2,3
11.0.G.B	WICK DRAINS	LF	345,000	0.57	196,650	29,498	15.0%	1,2,3
11.0.G.B	EXTRA BERM WICK DRAINS	LF	68,714	0.58	39,854	5,978	15.0%	1,2,3
11.0.G.B	RELIEF WELLS	EA	36	18,898.33	680,340	102,051	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 1	EA	1	7,140.00	7,140	1,071	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 2	EA	1	15,200.00	15,200	2,280	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 3	EA	1	15,400.00	15,400	2,310	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 4	EA	1	15,600.00	15,600	2,340	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 5	EA	1	15,500.00	15,500	2,325	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 6	EA	1	15,300.00	15,300	2,295	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 7	EA	1	15,300.00	15,300	2,295	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 8	EA	1	15,200.00	15,200	2,280	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 9	EA	1	15,300.00	15,300	2,295	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 10	EA	1	15,300.00	15,300	2,295	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 11	EA	1	15,300.00	15,300	2,295	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 12	EA	1	18,100.00	18,100	2,715	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 13	EA	1	18,100.00	18,100	2,715	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 14	EA	1	18,100.00	18,100	2,715	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 15	EA	1	18,100.00	18,100	2,715	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 16	EA	1	18,200.00	18,200	2,730	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 17	EA	1	21,700.00	21,700	3,255	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 18	EA	1	21,700.00	21,700	3,255	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 19	EA	1	21,600.00	21,600	3,240	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 20	EA	1	21,600.00	21,600	3,240	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 21	EA	1	21,600.00	21,600	3,240	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 22	EA	1	21,600.00	21,600	3,240	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 23	EA	1	21,600.00	21,600	3,240	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 24	EA	1	21,500.00	21,500	3,225	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 25	EA	1	21,500.00	21,500	3,225	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 26	EA	1	21,200.00	21,200	3,180	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 27	EA	1	21,200.00	21,200	3,180	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 28	EA	1	21,300.00	21,300	3,195	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 29	EA	1	21,300.00	21,300	3,195	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 30	EA	1	21,500.00	21,500	3,225	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 31	EA	1	21,400.00	21,400	3,210	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 32	EA	1	21,500.00	21,500	3,225	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 33	EA	1	21,400.00	21,400	3,210	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 34	EA	1	21,400.00	21,400	3,210	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 35	EA	1	21,400.00	21,400	3,210	15.0%	1,2,3
11.0.G.B	RELIEF WELL NO. 36	EA	1	21,200.00	21,200	3,180	15.0%	1,2,3
11.0.G.-	REINFORCED CONCRETE PIPE	JOB	1	506,162.00	506,162	92,283	18.2%	1,2,3
11.0.G.B	24" RCP CLASS IV	LF	288	46.50	13,392	2,263	16.9%	1,2,3
11.0.G.B	42" RCP CLASS III	LF	482	142.00	68,444	13,073	19.1%	1,2,3
11.0.G.B	54" RCP CLASS III	LF	394	220.00	86,680	17,180	19.8%	1,2,3
11.0.G.B	60" RCP CLASS III	LF	392	160.00	62,720	11,666	18.6%	1,2,3

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
11.0.G.B	66" RCP CLASS III	LF	334	192.00	64,128	11,928	18.6%	1,2,3
11.0.G.B	72" RCP CLASS III	LF	336	189.00	63,504	11,304	17.8%	1,2,3
11.0.G.B	30" RCP CLASS III	LF	198	108.00	21,384	2,887	13.5%	1,2,3
11.0.G.B	30" RCP CLASS III	LF	206	65.00	13,390	2,116	15.8%	1,2,3
11.0.G.B	36" RCP CLASS III	LF	182	77.40	14,087	2,367	16.8%	1,2,3
11.0.G.B	48" RCP CLASS III	LF	154	110.00	16,940	3,049	18.0%	1,2,3
11.0.G.B	48" RCP CLASS III	LF	400	116.00	46,400	8,491	18.3%	1,2,3
11.0.G.B	36" RCP CLASS III	LF	222	72.80	16,162	2,861	17.7%	1,2,3
11.0.G.B	24" RCP CLASS III	LF	250	47.30	11,825	1,975	16.7%	1,2,3
11.0.G.B	18" RCP CLASS III	LF	190	37.40	7,106	1,123	15.8%	1,2,3
11.0.G.-	INLETS	JOB	1	118,770.00	118,770	21,428	18.0%	1,2,3
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11.0.G.B	INLET 1A	JOB	1	9,890.00	9,890	1,978	20.0%	1,2,3
11.0.G.B	INLET 2A	JOB	1	6,130.00	6,130	1,085	17.7%	1,2,3
11.0.G.B	INLET 2B	JOB	1	6,270.00	6,270	1,116	17.8%	1,2,3
11.0.G.B	INLET 3A	JOB	1	7,840.00	7,840	1,419	18.1%	1,2,3
11.0.G.B	INLET 4A	JOB	1	8,070.00	8,070	1,461	18.1%	1,2,3
11.0.G.B	INLET 5A	JOB	1	8,690.00	8,690	1,582	18.2%	1,2,3
11.0.G.B	INLET 6A	JOB	1	7,190.00	7,190	1,294	18.0%	1,2,3
11.0.G.B	INLET 7A	JOB	1	6,130.00	6,130	1,091	17.8%	1,2,3
11.0.G.B	INLET 7B	JOB	1	9,180.00	9,180	1,698	18.5%	1,2,3
11.0.G.B	INLET 8A	JOB	1	5,140.00	5,140	905	17.6%	1,2,3
11.0.G.B	INLET 9A	JOB	1	5,140.00	5,140	905	17.6%	1,2,3
11.0.G.B	INLET 10A	JOB	1	13,900.00	13,900	2,377	17.1%	1,2,3
11.0.G.B	INLET 11A	JOB	1	9,030.00	9,030	1,671	18.5%	1,2,3
11.0.G.B	INLET 12A	JOB	1	5,240.00	5,240	922	17.6%	1,2,3
11.0.G.B	INLET 13A	JOB	1	5,390.00	5,390	949	17.6%	1,2,3
11.0.G.B	INLET 13B	JOB	1	5,540.00	5,540	975	17.6%	1,2,3
11.0.G.B	OUTLET B	JOB	1	242,750.00	242,750	45,126	18.6%	1,2,3
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11.0.G.B	CONCRETE WALLS	CY	205	85.50	17,528	3,506	20.0%	1,2,3
11.0.G.B	CONCRETE BASE SLAB	CY	15	94.40	1,416	283	20.0%	1,2,3
11.0.G.B	CONCRETE TOP SLAB	CY	2	119.00	179	35	19.8%	1,2,3
11.0.G.B	WALL FORMS	SF	5,726	6.74	38,593	7,719	20.0%	1,2,3
11.0.G.B	BASE SLAB FORMS	SF	89	3.40	303	61	20.1%	1,2,3
11.0.G.B	TOP SLAB FORMS	SF	71	8.99	638	128	20.1%	1,2,3
11.0.G.B	REINFORCING	LBS	29,948	0.49	14,675	2,935	20.0%	1,2,3
11.0.G.B	CURED SURFACE	SF	6,231	0.10	623	125	20.1%	1,2,3
11.0.G.B	FINISHED SURFACE	SF	346	0.71	246	49	19.9%	1,2,3
11.0.G.B	LADDERS	LBS	447	4.03	1,801	360	20.0%	1,2,3
11.0.G.B	PLATFORMS	LBS	241	1.09	263	53	20.2%	1,2,3
11.0.G.B	HANDRAIL	LBS	1,114	4.05	4,512	902	20.0%	1,2,3
11.0.G.B	STEEL GRATING	LBS	746	1.09	813	163	20.0%	1,2,3
11.0.G.B	DIAMOND STEEL PANELS	LBS	408	1.69	690	138	20.0%	1,2,3
11.0.G.B	BULKHEAD	LBS	3,000	1.05	3,150	630	20.0%	1,2,3
11.0.G.B	SLUICEGATE 72" X 72"	EA	1	32,400.00	32,400	6,480	20.0%	1,2,3
11.0.G.B	72" RCP 6000D	LF	37	383.00	14,171	2,834	20.0%	1,2,3
11.0.G.B	72" RCP 5000D	LF	53	350.00	18,550	3,710	20.0%	1,2,3
11.0.G.B	48" RCP 6000D	LF	86	212.00	18,232	3,646	20.0%	1,2,3
11.0.G.B	48" RCP 5000D	LF	118	177.00	20,886	4,177	20.0%	1,2,3

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
11.0.G.B	48"' RCP CLASS 5 TIED	LF	38	161.00	6,118	1,224	20.0%	1,2,3
11.0.G.B	48" RCP END SECTION	EA	2	912.00	1,824	365	20.0%	1,2,3
11.0.G.B	EXCAVATION PIPES	CY	11,261	0.90	10,135	1,014	10.0%	1,2,3
11.0.G.B	BACKFILL	CY	11,038	2.14	23,621	2,362	10.0%	1,2,3
11.0.G.B	SHEETPILE PZ 27	SF	384	12.70	4,877	975	20.0%	1,2,3
11.0.G.B	RIPRAP @SCOUR HOLE	CY	116	35.60	4,130	826	20.0%	1,2,3
11.0.G.B	BEDDING @ SCOUR HOLE	CY	58	32.50	1,885	377	20.0%	1,2,3
11.0.G.B	EXCAVATION @ SCOUR HOLE	CY	252	1.95	491	49	10.0%	1,2,3
11.0.G.B OUTLET C		JOB	1	238,021.00	238,021	43,141	18.1%	1,2,3
11.0.G.B	CONCRETE WALLS	CY	205	85.50	17,528	3,506	20.0%	1,2,3
11.0.G.B	BASE SLAB CONCRETE	CY	15	94.40	1,416	283	20.0%	1,2,3
11.0.G.B	TOP SLAB CONCRETE	CY	3	95.40	267	53	19.9%	1,2,3
11.0.G.B	WALL FORMS	SF	5,757	6.74	38,802	7,760	20.0%	1,2,3
11.0.G.B	BASE SLAB FORMS	SF	89	3.40	303	61	20.1%	1,2,3
11.0.G.B	TOP SLAB FORMS	SF	40	9.00	360	72	20.0%	1,2,3
11.0.G.B	REINFORCING	LBS	30,124	0.49	14,761	2,952	20.0%	1,2,3
11.0.G.B	FINISHED SURFACE	SF	314	0.71	223	45	20.2%	1,2,3
11.0.G.B	CURING COMPOUND	SF	6,200	0.10	620	124	20.0%	1,2,3
11.0.G.B	LADDERS	LBS	447	4.03	1,801	360	20.0%	1,2,3
11.0.G.B	PLATFORMS	LBS	241	1.09	263	53	20.2%	1,2,3
11.0.G.B	HANDRAIL	LBS	1,114	4.05	4,512	902	20.0%	1,2,3
11.0.G.B	STEEL GRATING	LBS	747	1.09	814	163	20.0%	1,2,3
11.0.G.B	STEEL PANELS	LBS	899	0.77	692	138	19.9%	1,2,3
11.0.G.B	BULKHEAD	LBS	3,000	1.05	3,150	630	20.0%	1,2,3
11.0.G.B	SLUICEGATE 72" X 72"	JOB	1	32,400.00	32,400	6,480	20.0%	1,2,3
11.0.G.B	66" RCP 6000D	LF	35	312.00	10,920	2,184	20.0%	1,2,3
11.0.G.B	66" RCP 5000D	LF	52	286.00	14,872	2,974	20.0%	1,2,3
11.0.G.B	66" CLASS V	LF	7	230.00	1,495	299	20.0%	1,2,3
11.0.G.B	48" 6000D	LF	63	212.00	13,356	2,671	20.0%	1,2,3
11.0.G.B	48" 5000D	LF	118	177.00	20,886	4,177	20.0%	1,2,3
11.0.G.B	48" TIED CLASS V	LF	38	161.00	6,118	1,224	20.0%	1,2,3
11.0.G.B	48" END SECTION	EA	2	912.00	1,824	365	20.0%	1,2,3
11.0.G.B	EXCAVATION PIPES	CY	8,680	0.90	7,812	781	10.0%	1,2,3
11.0.G.B	BACKFILL PIPES	CY	8,486	4.28	36,320	3,632	10.0%	1,2,3
11.0.G.B	RIPRAP @ SCOUR HOLE	CY	116	35.60	4,130	826	20.0%	1,2,3
11.0.G.B	BEDDING@SCOUR HOLE	CY	58	32.50	1,885	377	20.0%	1,2,3
11.0.G.B	EXCAVATION SCOUR HOLE	CY	252	1.95	491	49	10.0%	1,2,3
11.0.G.B MANHOLE 1		JOB	1	3,391.00	3,391	678	20.0%	1,2,3
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTMENT RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	48" RISER	LF	10	126.00	1,222	244	20.0%	1,2,3
11.0.G.B	BASE SLAB	EA	1	243.00	243	49	20.2%	1,2,3
11.0.G.B	LEAN CONCRETE	CY	0	460.00	74	15	20.3%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.G.B MANHOLE 2		JOB	1	8,028.00	8,028	1,605	20.0%	1,2,3

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTMENT RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	48" RISER	LF	5	101.00	467	93	19.9%	1,2,3
11.0.G.B	PRECAST TEE 54" X 48"	EA	1	1,550.00	1,550	310	20.0%	1,2,3
11.0.G.B	ARCH CONCRETE	CY	25	83.50	2,088	418	20.0%	1,2,3
11.0.G.B	ARCH FORMS	SF	264	5.47	1,444	289	20.0%	1,2,3
11.0.G.B	ARCH REINFORCING	LBS	1,280	0.49	627	125	19.9%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.G.B	MANHOLE 3	JOB	1	7,459.00	7,459	1,491	20.0%	1,2,3
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTMENT RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB 48" X 6"	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	48" RISER	LF	5	205.00	947	189	20.0%	1,2,3
11.0.G.B	PRECAST TEE 60" X48"	EA	1	2,090.00	2,090	418	20.0%	1,2,3
11.0.G.B	ARCH CONCRETE	CY	14	83.50	1,169	234	20.0%	1,2,3
11.0.G.B	ARCH FORMS	SF	192	5.47	1,050	210	20.0%	1,2,3
11.0.G.B	ARCH REINFORCING	LBS	716	0.49	351	70	19.9%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.G.B	MANHOLE 4	JOB	1	7,547.00	7,547	1,509	20.0%	1,2,3
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTMENT RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB 48"	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	RISER 48"	LF	6	155.00	946	189	20.0%	1,2,3
11.0.G.B	PRECAST TEE 66" X 48"	EA	1	2,090.00	2,090	418	20.0%	1,2,3
11.0.G.B	ARCH CONCRETE	CY	15	83.50	1,253	251	20.0%	1,2,3
11.0.G.B	ARCH FORMS	SF	212	4.96	1,052	210	20.0%	1,2,3
11.0.G.B	ARCH REINFORCING	LBS	770	0.46	354	71	20.1%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.G.B	MANHOLE 5	JOB	1	5,512.00	5,512	1,102	20.0%	1,2,3
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTMENT RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB 48" X 6"	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	RISER 48"'	EA	1	1,190.00	1,190	238	20.0%	1,2,3
11.0.G.B	PRECAST TEE 72" X 48"	EA	1	2,470.00	2,470	494	20.0%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.G.B	MANHOLE 6	JOB	1	21,421.00	21,421	4,284	20.0%	1,2,3
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTMENT RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB 48" X 6"	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	RISER 48"	LF	10	126.00	1,260	252	20.0%	1,2,3
11.0.G.B	TOP SLAB CONCRETE	CY	5	97.90	490	98	20.0%	1,2,3
11.0.G.B	WALL CONCRETE	CY	14	685.00	9,590	1,918	20.0%	1,2,3
11.0.G.B	BASE SLAB CONCRETE	CY	4	87.40	315	63	20.0%	1,2,3

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
11.0.G.B	TOP SLAB FORMS	SF	91	8.99	818	164	20.0%	1,2,3
11.0.G.B	WALL FORMS	SF	775	6.74	5,224	1,045	20.0%	1,2,3
11.0.G.B	BASE SLAB FORMS	SF	33	3.40	112	22	19.6%	1,2,3
11.0.G.B	REINFORCING	LBS	2,420	0.49	1,186	237	20.0%	1,2,3
11.0.G.B	FINISH AREA	SF	235	0.71	167	33	19.8%	1,2,3
11.0.G.B	CURING COMPOUND	SF	1,130	0.10	113	23	20.4%	1,2,3
11.0.G.B	LEAN CONCRETE	CY	2	147.00	294	59	20.1%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.G.B	MANHOLE 7	JOB	1	5,386.00	5,386	1,077	20.0%	1,2,3
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTING RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB 48" X 6"	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	RISER 48"	LF	7	126.00	819	164	20.0%	1,2,3
11.0.G.B	MIDDLE SLAB 72" X 8"	EA	1	325.00	325	65	20.0%	1,2,3
11.0.G.B	BARREL 60"	LF	5	316.00	1,580	316	20.0%	1,2,3
11.0.G.B	BASE SLAB 92" X 8"	EA	1	516.00	516	103	20.0%	1,2,3
11.0.G.B	LEAN CONCRETE	CY	0	736.00	294	59	20.1%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.G.B	MANHOLE 8	JOB	1	5,489.00	5,489	1,098	20.0%	1,2,3
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTING RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB 48" X 6"	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	RISER 48"	LF	7	126.00	819	164	20.0%	1,2,3
11.0.G.B	MIDDLE SLAB 72" X 8"	EA	1	404.00	404	81	20.0%	1,2,3
11.0.G.B	BARELL 60"	LF	5	215.00	1,075	215	20.0%	1,2,3
11.0.G.B	BASE SLAB 120" X 8"	EA	1	879.00	879	176	20.0%	1,2,3
11.0.G.B	LEAN CONCRETE	CY	1	575.00	460	92	20.0%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.G.B	MANHOLE 9	EA	1	6,983.00	6,983	1,395	20.0%	1,2,3
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTING RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB 48" X 6"	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	RISER 48" X 6"	LF	7	177.00	1,186	237	20.0%	1,2,3
11.0.G.B	PRECAST TEE 48" X 48"	EA	1	1,620.00	1,620	324	20.0%	1,2,3
11.0.G.B	ARCH CONCRETE	CY	13	86.70	1,127	225	20.0%	1,2,3
11.0.G.B	ARCH FORMS	SF	161	5.47	881	176	20.0%	1,2,3
11.0.G.B	ARCH REINFORCING	LBS	646	0.49	317	63	19.9%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.G.B	MANHOLE 10	JOB	1	11,776.00	11,776	2,355	20.0%	1,2,3
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTING RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB 48" X 8"	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	RISER 72"	EA	1	2,030.00	2,030	406	20.0%	1,2,3
11.0.G.B	CONCRETE TOP SLAB	CY	4	91.30	356	71	19.9%	1,2,3

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
11.0.G.B	CONCRETE WALLS	CY	8	89.40	751	150	20.0%	1,2,3
11.0.G.B	CONCRETE BASE SLAB	CY	10	82.60	826	165	20.0%	1,2,3
11.0.G.B	FORMS TOP SLAB	SF	74	8.99	665	133	20.0%	1,2,3
11.0.G.B	FORMS WALLS	SF	485	6.74	3,269	654	20.0%	1,2,3
11.0.G.B	FORMS BASE SLAB	SF	71	3.40	241	48	19.9%	1,2,3
11.0.G.B	REINFORCING	LBS	2,420	0.49	1,186	237	20.0%	1,2,3
11.0.G.B	FINISHED AREA	SF	209	0.71	148	30	20.3%	1,2,3
11.0.G.B	CURING COMPOUND	SF	837	0.10	84	17	20.2%	1,2,3
11.0.G.B	LEAN CONCRETE	CY	1	263.00	368	74	20.1%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.G.B	MANHOLE 11	JOB	1	4,907.00	4,907	980	20.0%	1,2,3
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTING RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB 48" X 6"	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	RISER 48"	LF	5	114.00	616	123	20.0%	1,2,3
11.0.G.B	PRECAST TEE 48" X 48"	EA	1	114.00	114	23	20.2%	1,2,3
11.0.G.B	ARCH CONCRETE	CY	13	86.70	1,127	225	20.0%	1,2,3
11.0.G.B	ARCH FORMS	SF	161	5.47	881	176	20.0%	1,2,3
11.0.G.B	REINFORCING	LBS	646	0.49	317	63	19.9%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.G.B	MANHOLE 12	JOB	1	4,602.00	4,602	921	20.0%	1,2,3
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTING RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB 48" X 6"	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	RISER 48"	LF	4	114.00	479	96	20.0%	1,2,3
11.0.G.B	MIDDLE SLAB 72" X 8"	EA	1	294.00	294	59	20.1%	1,2,3
11.0.G.B	BARELL 60"	LF	5	146.00	730	146	20.0%	1,2,3
11.0.G.B	BASE SLAB 120" X 8"	EA	1	879.00	879	176	20.0%	1,2,3
11.0.G.B	LEAN CONCRETE	CY	1	409.00	368	74	20.1%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.G.B	MANHOLE 13	JOB	1	3,819.00	3,819	763	20.0%	1,2,3
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTING RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB 48" X 6"	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	RISER 48"	LF	9	104.00	962	192	20.0%	1,2,3
11.0.G.B	BASE SLAB 100" X 8"	EA	1	636.00	636	127	20.0%	1,2,3
11.0.G.B	LEAN CONCRETE	CY	0	1,230.00	369	74	20.1%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.G.B	MANHOLE 14	JOB	1	3,965.00	3,965	793	20.0%	1,2,3
11.0.G.B	CASTING	EA	1	220.00	220	44	20.0%	1,2,3
11.0.G.B	ADJUSTING RINGS	EA	2	32.80	66	13	19.7%	1,2,3
11.0.G.B	TOP SLAB 48" X 6"	EA	1	226.00	226	45	19.9%	1,2,3
11.0.G.B	RISER 48"	LF	11	114.00	1,197	239	20.0%	1,2,3
11.0.G.B	BASE SLAB 92" X 8"	EA	1	548.00	548	110	20.1%	1,2,3

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
11.0.G.B	LEAN CONCRETE	CY	0	3,680.00	368	74	20.1%	1,2,3
11.0.G.B	GUARD POSTS	EA	5	268.00	1,340	268	20.0%	1,2,3
11.0.R.B	LANDSCAPING	JOB	1	107,150.00	107,150	21,430	20.0%	1,2,3
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11.0.C.B	LANDSCAPING TREES	EA	350	233.00	81,550	16,310	20.0%	1,2,3
11.0.C.B	LANDSCAPING SHRUBS	EA	1,000	25.60	25,600	5,120	20.0%	1,2,3
11.0.R.B	POND MARKERS	EA	10	178.00	1,780	356	20.0%	1,2,3
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11.0.R.B	POND MARKERS	EA	10	178.00	1,780	356	20.0%	1,2,3
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	Total Estimated Cost				4,698,824			
	Contingencies			18.23%		856,426		

	Total Estimated Cost and Contingencies					5,555,250		

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
13.-.-.-	PUMPING PLANT							
13.0.A.-	MOB/DEMOB & PREP	EA	1	18,900.00	18,900	3,780	20.0%	1,2,3
13.0.A.B	MOB AND DEMOB & PREP	JOB	1	18,900.00	18,900	3,780	20.0%	1,2,3
13.0.D.-	SITEWORK	JOB	1	13,261.00	13,261	2,652	20.0%	1,2,3
13.0.D.B	AGGREGATE BASE COURSE	CY	27	19.70	532	106	19.9%	1,2,3
13.0.D.B	BINDER COURSE	SY	373	4.95	1,846	369	20.0%	1,2,3
13.0.D.B	TACK COAT	SY	373	0.03	11	2	18.2%	1,2,3
13.0.D.B	WEAR COURSE	SY	373	5.78	2,156	431	20.0%	1,2,3
13.0.D.B	STRIPING	LF	100	0.14	14	3	21.4%	1,2,3
13.0.D.B	SIDEWALK	SY	13	26.90	358	72	20.1%	1,2,3
13.0.D.B	EXCAVATION	CY	3,177	1.67	5,306	1,061	20.0%	1,2,3
13.0.D.B	BACKFILL	CY	2,247	0.69	1,550	310	20.0%	1,2,3
13.0.D.B	SPOIL TO DISPOSAL	CY	930	1.60	1,488	298	20.0%	1,2,3
13.0.1.-	SUBSTRUCTURE	JOB	1	99,042.00	99,042	19,808	20.0%	1,2,3
13.0.1.C	CONCRETE WALLS	CY	193	87.50	16,888	3,378	20.0%	1,2,3
13.0.1.C	CONCRETE BASE SLAB	CY	107	87.50	9,363	1,873	20.0%	1,2,3
13.0.1.C	CONCRETE TOP SLAB	CY	36	65.20	2,347	469	20.0%	1,2,3
13.0.1.C	WALL FORMS	SF	5,746	5.96	34,246	6,849	20.0%	1,2,3
13.0.1.C	BASE SLAB FORMS	SF	310	3.40	1,054	211	20.0%	1,2,3
13.0.1.C	TOP SLAB FORMS	SF	529	5.47	2,894	579	20.0%	1,2,3
13.0.1.C	REINFORCING	LBS	36,839	0.49	18,051	3,610	20.0%	1,2,3
13.0.1.C	FINISHED SURFACE	SF	1,888	0.71	1,340	268	20.0%	1,2,3
13.0.1.C	CURING COMPOUND	SF	8,474	0.10	847	169	20.0%	1,2,3
13.0.1.E	LADDERS	LBS	497	1.02	507	101	19.9%	1,2,3
13.0.1.E	PLATFORM	LBS	344	1.10	378	76	20.1%	1,2,3
13.0.1.E	HANDRAIL	LBS	156	14.40	2,246	449	20.0%	1,2,3
13.0.1.E	STEEL GRATING	LBS	1,020	0.50	510	102	20.0%	1,2,3
13.0.1.E	DIAMOND STEEL PANELS	LBS	255	0.71	181	36	19.9%	1,2,3
13.0.1.E	TRASH RACK	LBS	4,587	1.05	4,816	963	20.0%	1,2,3
13.0.1.B	RAIL, BEAMS & SUPPORTS	LBS	1,377	2.45	3,374	675	20.0%	1,2,3
13.0.4.-	GATES AND VALVES	EA	3	36,600.00	109,800	21,960	20.0%	1,2,3
13.0.4.Q	SLUICE GATE 48" X 48"	EA	3	36,600.00	109,800	21,960	20.0%	1,2,3
13.0.2.-	SUPERSTRUCTURE	JOB	1	15,402.00	15,402	3,080	20.0%	1,2,3
13.0.2.C	CONCRETE WALLS	CY	46	91.70	4,172	834	20.0%	1,2,3
13.0.2.C	WALL FORMS	SF	1,229	6.11	7,509	1,502	20.0%	1,2,3
13.0.2.C	REINFORCING	LBS	5,005	0.49	2,452	490	20.0%	1,2,3
13.0.2.C	FINISHED SURFACE	SF	105	0.71	75	15	20.0%	1,2,3
13.0.2.C	CURING COMPOUND	SF	1,334	0.10	133	27	20.3%	1,2,3
13.0.2.C	CONCRETE STAIRS	CY	1	884.00	1,061	212	20.0%	1,2,3
13.0.2.-	THERMAL AND MOISTURE	JOB	1	14,424.00	14,424	2,883	20.0%	1,2,3

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
13.0.2.G	GLU LAN 4" X 12"	LF	70	3.82	267	53	19.9%	1,2,3
13.0.2.G	2" X 12" WALL NAILER	LF	114	2.96	337	67	19.9%	1,2,3
13.0.2.G	FASTENING PLATES	EA	14	412.00	5,768	1,154	20.0%	1,2,3
13.0.2.G	GLU LAM DECK	SF	770	1.59	1,224	245	20.0%	1,2,3
13.0.2.G	BLDG. PAPER	SF	770	0.10	77	15	19.5%	1,2,3
13.0.2.G	ROOFING FELT 30#	SF	770	0.10	77	15	19.5%	1,2,3
13.0.2.G	STAND SEAM METAL ROOF	SF	770	5.48	4,220	844	20.0%	1,2,3
13.0.2.G	FLASHING METAL	SF	150	5.48	822	164	20.0%	1,2,3
13.0.2.G	WOOD TRIM 1 X 12	LF	110	2.96	326	65	19.9%	1,2,3
13.0.2.G	FACIA STRIPS 3.5 "	LF	220	3.82	840	168	20.0%	1,2,3
13.0.2.G	ROOF EDGE 1 X 4	LF	122	3.82	466	93	20.0%	1,2,3
13.0.2.-	DOORS AND WINDOWS	JOB	1	7,635.00	7,635	1,525	20.0%	1,2,3
13.0.2.H	WINDOW 2' X 4' ENAM ALU	EA	2	640.00	1,280	256	20.0%	1,2,3
13.0.2.H	WINDOW 2' X 2' ENAM ALM	EA	1	520.00	520	104	20.0%	1,2,3
13.0.2.H	LOUVERS	EA	2	277.00	554	111	20.0%	1,2,3
13.0.2.B	LOUVERS	EA	2	493.00	986	197	20.0%	1,2,3
13.0.2.H	HANDRAIL 1/14"	LF	10	45.10	451	90	20.0%	1,2,3
13.0.2.H	3" PIPE	LF	12	41.40	497	99	19.9%	1,2,3
13.0.2.H	3" CHANNEL	LF	24	4.35	104	21	20.2%	1,2,3
13.0.2.H	1/2" STEEL BAR	LF	75	2.65	199	40	20.1%	1,2,3
13.0.2.G	1" STEEL BAR	LF	28	10.60	297	59	19.9%	1,2,3
13.0.2.H	DOOR FRAME 6'4" X 10'2"	EA	1	667.00	667	133	19.9%	1,2,3
13.0.2.H	DBL. DOOR 6' X 10'2"	EA	1	1,250.00	1,250	250	20.0%	1,2,3
13.0.2.H	PAIR BUTTS	EA	4	68.10	272	54	19.9%	1,2,3
13.0.2.H	THRESHOLD	EA	1	256.00	256	51	19.9%	1,2,3
13.0.2.B	DEAD BOLT	EA	1	302.00	302	60	19.9%	1,2,3
13.0.2.-	MASONRY	JOB	1	19,065.00	19,065	3,814	20.0%	1,2,3
13.0.2.D	FACE BRICK	SF	1,753	7.58	13,288	2,658	20.0%	1,2,3
13.0.2.D	COPING STONE	LF	51	40.60	2,071	414	20.0%	1,2,3
13.0.2.D	RELIEF ANGLES	LF	186	19.10	3,553	711	20.0%	1,2,3
13.0.2.D	BRICK ARCH	LF	32	4.79	153	31	20.3%	1,2,3
13.0.2.-	FINISHES	SF	574	0.65	373	75	20.1%	1,2,3
13.0.2.J	PAINTING	SF	574	0.65	373	75	20.1%	1,2,3
13.0.3.-	ELECTRICAL	JOB	1	84,177.00	84,177	16,834	20.0%	1,2,3
13.0.6.R	TRANSFORMER PAD	EA	1	231.00	231	46	19.9%	1,2,3
13.0.6.R	TRENCH	LF	50	0.50	25	5	20.0%	1,2,3
13.0.6.R	CONDUIT RIGID STEEL 3"	LF	100	6.88	688	138	20.1%	1,2,3
13.0.6.R	CONDUIT 3" ELBOW	EA	4	41.80	167	33	19.8%	1,2,3
13.0.6.R	GROUNDING BUSHING 3"	EA	4	13.40	54	11	20.4%	1,2,3
13.0.6.R	WIRE 500 MCM	LF	500	0.35	175	35	20.0%	1,2,3
13.0.6.R	CABLE TERMINATIONS	EA	8	66.80	534	107	20.0%	1,2,3
13.0.2.R	GROUNDING CONDUCTOR	LF	100	1.57	157	31	19.7%	1,2,3
13.0.3.R	SERVICE SECTION 800 AMP	EA	1	1,170.00	1,170	234	20.0%	1,2,3
13.0.3.R	LIGHTING ARRESTOR	EA	1	442.00	442	88	19.9%	1,2,3

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
13.0.3.R	MAIN CIRC.BRKER.800 AMP	EA	1	2,840.00	2,840	568	20.0%	1,2,3
13.0.3.R	MAIN CONTROL SECTION	EA	5	1,140.00	5,700	1,140	20.0%	1,2,3
13.0.3.R	MOTOR STARTERS	EA	3	9,850.00	29,550	5,910	20.0%	1,2,3
13.0.3.R	MOTOR STARTER SIZE 0	EA	1	360.00	360	72	20.0%	1,2,3
13.0.3.R	CIRCUIT BREAKER 20 AMP	EA	5	329.00	1,645	329	20.0%	1,2,3
13.0.3.R	CONTROL RELAY	EA	16	71.70	1,147	229	20.0%	1,2,3
13.0.3.R	TIMING RELAY	EA	8	174.00	1,392	278	20.0%	1,2,3
13.0.3.R	CONTROL TRANSFORMER	EA	1	37,900.00	37,900	7,580	20.0%	1,2,3
13.0.3.-	MECHANICAL	JOB	1	147,219.00	147,219	29,444	20.0%	1,2,3
13.0.3.Q	PUMPS 100 HP	EA	3	33,600.00	100,800	20,160	20.0%	1,2,3
13.0.3.Q	DISCHARGE PIPE 14" DIP	LF	320	56.90	18,208	3,642	20.0%	1,2,3
13.0.3.Q	FLAP GATES 14"	EA	3	3,790.00	11,370	2,274	20.0%	1,2,3
13.0.3.Q	PUMP HOIST 2 TON 10FPM	EA	1	9,340.00	9,340	1,868	20.0%	1,2,3
13.0.3.Q	SUMP PUMP 150 GPM	EA	1	3,080.00	3,080	616	20.0%	1,2,3
13.0.3.Q	UNIT HEATER 5KW	EA	2	334.00	668	134	20.1%	1,2,3
13.0.3.Q	GATE OPERATOR	EA	1	2,690.00	2,690	538	20.0%	1,2,3
13.0.3.Q	SUMP VENT FAN 1/3 HP	EA	2	130.00	260	52	20.0%	1,2,3
13.0.3.Q	SUMP VENT ROUND DUCT 8"	LF	40	8.40	336	67	19.9%	1,2,3
13.0.3.Q	FAN 1 HP	EA	1	467.00	467	93	19.9%	1,2,3
	Total Estimated Cost				529,298			
	Contingencies			20.00%		105,855		
	Total Estimated Cost and Contingencies					635,153		

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
14.-.-.-	RECREATION FACILITIES							
14.0.A.-	MOBILIZATION AND PREP	JOB	1	6,310.00	6,310	1,262	20.0%	1,2,3
14.0.A.1	MOBILIZATION & PREP	JOB	1	6,310.00	6,310	1,262	20.0%	1,2,3
14.0.3.-	RECR.PATH, 28+80-55+05	SY	2,333	5.86	13,671	2,734	20.0%	1,2,3
14.0.3.B	BITUMINOUS BIKE PATH	SY	2,333	5.86	13,671	2,734	20.0%	1,2,3
14.0.3.-	RECR.PATH,55+65-71+17	SY	1,380	5.91	8,156	1,631	20.0%	1,2,3
14.0.3.B	BITUMINOUS BIKE PATH	SY	1,380	5.91	8,156	1,631	20.0%	1,2,3
14.0.3.-	RECR.PATH COURTHOUSE LK	SY	3,511	5.78	20,294	4,059	20.0%	1,2,3
14.0.3.B	BITUMINOUS COURTHOUSE	SY	3,511	5.78	20,294	4,059	20.0%	1,2,3
14.0.3.-	LEVEE TRAIL COURTHOUSE	CY	585	12.00	7,020	1,404	20.0%	1,2,3
14.0.3.B	AGGREGATE BASE COURSE	CY	585	12.00	7,020	1,404	20.0%	1,2,3
14.0.3.-	STRIPPING	CY	732	2.85	2,083	417	20.0%	1,2,3
14.0.3.B	STRIPPING	CY	732	1.37	1,003	201	20.0%	1,2,3
14.0.3.B	HAUL TOPSOIL OFFSITE	CY	500	2.16	1,080	216	20.0%	1,2,3
14.0.3.-	TOPSOIL	EA	98	1.93	189	38	20.1%	1,2,3
14.0.3.B	TOPSOIL	CY	98	1.93	189	38	20.1%	1,2,3
14.0.3.-	SEEDING	ACR	0	10,100.00	2,020	404	20.0%	1,2,3
14.0.3.B	SEEDING	ACR	0	10,100.00	2,020	404	20.0%	1,2,3
14.0.3.-	KIOSKS	EA	3	1,657.33	4,972	996	20.0%	1,2,3
14.0.3.F	TIMBER POSTS	EA	9	38.40	346	69	19.9%	1,2,3
14.0.3.F	ROUGH SAWN VERTICALS	EA	102	4.39	448	90	20.1%	1,2,3
14.0.3.F	ROOF JOISTS	EA	30	16.70	501	100	20.0%	1,2,3
14.0.3.F	PANEL RAILS	EA	27	4.23	114	23	20.2%	1,2,3
14.0.3.F	ROOF FASICIA	EA	9	15.90	143	29	20.3%	1,2,3
14.0.3.F	STEEL PLATES	EA	45	18.50	833	167	20.0%	1,2,3
14.0.3.F	POST ANCHORS	EA	9	58.70	528	106	20.1%	1,2,3
14.0.3.F	CONCRETE	CY	2	170.00	340	68	20.0%	1,2,3
14.0.3.F	SIGNS	EA	3	573.00	1,719	344	20.0%	1,2,3
14.0.3.-	RECREATION TRAIL RAMP	JOB	1	21,540.00	21,540	4,308	20.0%	1,2,3
14.0.3.B	AGGREGATE BASE COURSE	CY	83	19.70	1,635	327	20.0%	1,2,3
14.0.3.B	IMPERVIOUS FILL	CY	2,500	4.33	10,825	2,165	20.0%	1,2,3
14.0.3.B	LOAD AT KUSKE PIT	CY	2,500	0.57	1,425	285	20.0%	1,2,3

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
14.0.3.B	HAUL FROM KUSKE PIT	CY	2,500	2.16	5,400	1,080	20.0%	1,2,3
14.0.3.B	BRIDGE RAILING	LF	50	45.10	2,255	451	20.0%	1,2,3
	Total Estimated Cost				86,255			
	Total Contingecies			20.00%		17,253		
	Total Estimated Cost plus Contingencies					103,508		

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
30.-.-.-	PLANNING, ENGINEERING AND DESIGN							
30.B.-.-	ENGINEERING AND DESIGN PRIOR TO 5/91	LS	1	808,100	SEE NOTE 1.	0		
30.E.-.-	GENERAL DESIGN MEMORANDUM	LS	1	165,000	165,000	0		5
30.G.-.-	FEATURE DESIGN MEMORANDUM							
30.G.-.-	ED-EG	LS	1	15,000	15,000	300	2.0%	6
30.G.-.-	ED-EF	LS	1	40,600	40,600	400	1.0%	6
30.G.-.-	ED-EJ	LS	1	82,300	82,300	800	1.0%	6
30.G.-.-	ED-ES	LS	1	62,900	62,900	600	1.0%	6
30.G.-.-	ED-ER	LS	1	43,700	43,700	400	1.0%	6
30.G.-.-	ED-EN	LS	1	47,500	47,500	500	1.0%	6
30.G.-.-	ED-FB	LS	1	91,400	91,400	300	0.3%	6
30.G.-.-	ED-FD	LS	1	141,700	141,700	1,200	0.9%	6
30.G.-.-	ED-FE	LS	1	80,300	80,300	700	0.9%	6
30.G.-.-	ED-FF	LS	1	13,900	13,900	100	0.7%	6
30.G.-.-	PD-GC	LS	1	1,100	1,100	100	9.0%	6
30.G.-.-	PD-GL	LS	1	7,200	7,200	100	1.4%	6
30.G.-.-	PD-GM	LS	1	15,500	15,500	400	2.6%	6
30.H.-.-	PLANS AND SPECIFICATIONS							
30.H.-.-	DESIGN BY AE CONTRACT	LS	1	390,000	390,000	58,000	14.9%	6
30.H.-.-	AE CONTRACT ADMINISTRATION							
30.H.-.-	ED-EG	LS	1	1,700	1,700	300	17.6%	6
30.H.-.-	ED-EF	LS	1	10,400	10,400	1,600	15.4%	6
30.H.-.-	ED-EJ	LS	1	38,300	38,300	5,700	14.9%	6
30.H.-.-	ED-ER	LS	1	17,400	17,400	2,600	14.9%	6
30.H.-.-	ED-ES	LS	1	49,600	49,600	7,400	14.9%	6
30.H.-.-	ED-EM	LS	1	30,400	30,400	4,600	15.1%	6
30.H.-.-	ED-FD	LS	1	14,800	14,800	2,200	14.9%	6
30.H.-.-	PD-GB	LS	1	2,600	2,600	400	15.4%	6
30.H.-.-	PD-GC	LS	1	4,300	4,300	700	16.3%	6
30.H.-.-	PD-GM	LS	1	1,700	1,700	300	17.6%	6
30.H.-.-	PD-GL	LS	1	6,100	6,100	900	14.8%	6
30.H.-.-	CO-C	LS	1	1,700	1,700	300	17.6%	6
30.H.-.-	CT-HC	LS	1	18,300	18,300	2,700	14.8%	6
30.H.-.-	LCPM-JR	LS	1	5,200	5,200	800	15.4%	6
30.N.-.-	ENGINEERING DURING CONCTRUCTION							
30.N.-.-	ARCHITECT ENGINEER	LS	1	118,300	118,300	17,700	15.0%	6
30.N.-.-	ED-EG	LS	1	1,700	1,700	300	17.6%	6
30.N.-.-	ED-EF	LS	1	1,700	1,700	300	17.6%	6
30.N.-.-	ED-EJ	LS	1	13,000	13,000	2,000	15.0%	6
30.N.-.-	ED-ER	LS	1	8,700	8,700	1,300	14.9%	6
30.N.-.-	ED-ES	LS	1	23,500	23,500	3,500	14.9%	6
30.N.-.-	ED-EM	LS	1	13,000	13,000	2,000	15.0%	6
30.N.-.-	ED-FD	LS	1	4,300	4,300	700	16.3%	6
30.N.-.-	PD-GL	LS	1	2,600	2,600	400	15.4%	6
30.N.-.-	CT-HC	LS	1	18,300	18,300	2,700	14.7%	6

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
30.N.-.-	LCPM-JR	LS	1	1,700	1,700	300	17.6%	6
	Total Estimated Cost				1,607,000			
	Contingencies			7.84%		126,000		
	Total Estimated Cost and Contingencies					1,733,000		

NOTES

1. ACCOUNT 30.B IS THE SUM OF ACCOUNTS 30.E AND 30.G.
2. TOTALS ARE ROUNDED TO THE NEAREST $1,000.00
3. FEDERAL,NONFEDERAL COST TO BE IN ACCORDANCE WITH 1986 WRDA.

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	CONTINGENCIES PERCENT	REASON
31.-.-.-	CONSTRUCTION MANAGEMENT							
31.-.-.-	CONSTRUCTION MANAGEMENT	LS	1	375,000	375,000	0	0.0%	7
					---------	--------		
	Total Estimated Cost				375,000			
	Contingencies			0.00%		0		

	Total Estimated Cost and Contingencies					375,000		

REASONS FOR CONTINGENCIES
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1. QUANTITY VARIATIONS
2. UNIT PRICE UNKNOWNS
3. UNKNOWN SITE CONDITIONS
4. LEGAL COST
5. NONE REQUIRED ON FUNDS TO DATE
6. UNKNOWN MANHOURS
7. CONTINGENCY INCLUDED IN AMOUNT

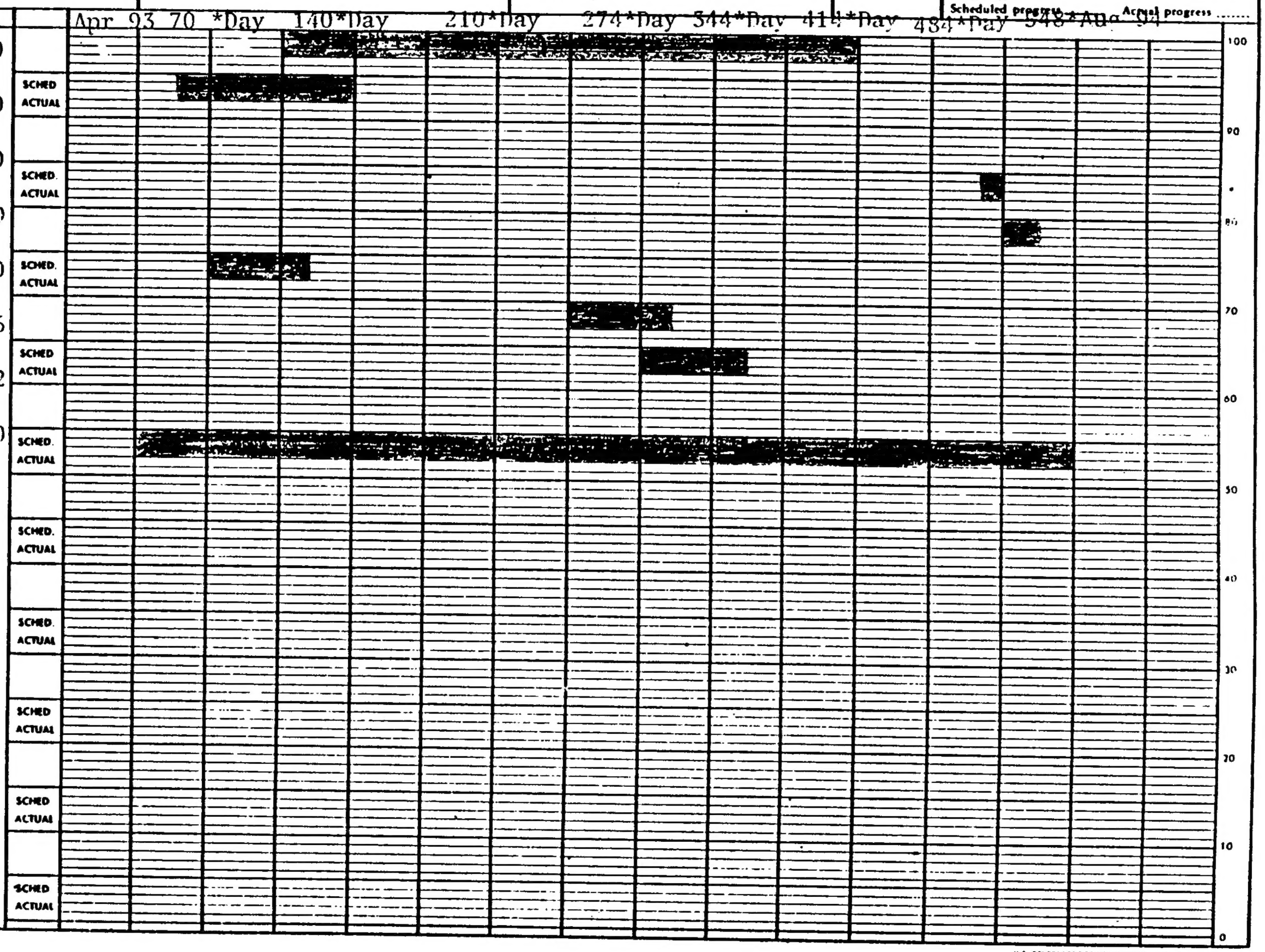
CONSTRUCTION PROGRESS CHART

REPORTS CONTROL SYMBOL

1. CONTRACTOR	3. PROJECT Chaska Stage IV	5. CONTRACT DESCRIPTION	6. SUBMITTED FOR APPROVAL — DATE
2. CONTRACT NUMBER	4. LOCATION		7. APPROVAL RECOMMENDED — DATE
			8. APPROVED — DATE

LEGEND
BARS: Scheduled progress to date of report; Actual progress (0 5 10)
CURVES: Scheduled progress .... Actual progress

PRINCIPAL CONTRACT FEATURE	LINE ITEM	WT.	ESTIMATED COST
Impervious Fill			912,000
Relief Wells			782,000
Pervious Fill			184,700
Riprap			220,429
Wick Drainage			271,980
Outlet B			287,876
Outlet C			281,162
Dewatering			436,000



G-24REV

ENG FORM 2454 1 JUNE 65 PREVIOUS EDITION MAY BE USED

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